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MECHANICS' REGISTER.

MAY, 1840.

Practical and Theoretical Mechanics and Chemistry.

On the Identity of Edwardsite and Monazite, by GUSTAV ROSE. *Extracted from the 1st No. of Poggendorf's "Annalen der Physik und der Chemie" for* 1840. *By* M. H. BOYE' AND J. C. BOOTH.

The Royal collection at Berlin received a fragment of Gneiss from Norwich, in Connecticut, containing a part of a crystal of Edwardsite, which, although fractured on either termination, had a sufficient number of planes remaining to determine its angles. *Sheppard** correctly referred this mineral to the oblique-rhombic system, and added that the prism was terminated by a four sided pyramid. He observed that the cleavage was sometimes perfect but generally uneven parallel to the oblique terminal plane, but very perfect parallel to the longer diagonal. He further remarks that it bore the closest resemblance to zircon, which the Monazite was supposed to be by *Menge*, who first found it in the Ilmen branch of the Uralian chain. The few measurements of Edwardsite nearly correspond with those of Monazite, excepting the inclination of an oblique terminal plane to the plane replacing the obtuse lateral edge, which, with Monazite, gave an angle of 100° 5′, with Edwardsite 103° 58′, but the calculation of the former was grounded on imperfect measurements. In regard to form, therefore, the two minerals correspond.

They also resemble each other in relation to other properties. Color, hyacinth-red to reddish brown, the lustre of Edwardsite somewhat stronger; hardness = 5 (apatite). Specific gravity of Edwardsite is rated too low by Sheppard = 4.2 to 4.6,—that of Monazite, according to Breithaupt = 4.992 to 5.079. In behaviour before the blow pipe alone, or with fluxes

* American Journal Arts and Science, xxxii, 162.

both alike, both infusible. Sheppard observes that the former fuses with great difficulty on the edges, but no such fusion was observable on the specimen in the Royal cabinet. There are some differences in their behaviour with acids, the former, according to Sheppard, being slightly affected by Aqua Regia, the Monazite, according to Kersten being decomposed by chlorohydric acid with the evolution of chlorine.

The apparent differences of their chemical composition may be reconciled. The Monazite was analyzed by Kersten, the Edwardsite by Sheppard.

Monazite.		*Edwardsite.*	
Peroxide of Cerium,	26.00	Peroxide of Cerium,	56.53
Oxide of Lanthanium,	23.40	Zirconia,	7.77
Thorina,	17.95	Alumina,	4.44
Peroxide of Tin,	2.10	Silica,	3.33
Protoxide of Manganese,	1.86	Protoxide of iron, Glucina,	traces.
Lime,	1.68	Magnesia,	
Zitanic acid, Potassa,	traces.	Phosphoric acid,	26.66
Phosphoric acid,	28.50		98.73
	98.49*		

The chief differences then are that Monazite contains both oxide of cerium and lanthanium, the Edwardsite only peroxide of cerium (Sheppard gives protoxide,) that the former contains thorina, the latter zirconia. Lanthanium is probably contained in Edwardsite, as it generally accompanies cerium, having been first discovered during the past year by Mosander. (was unknown to Sheppard.) In regard to thorina and zirconia, it can hardly be assumed that the given quantities are correct, since we have no accurate method of separating them from oxide of cerium; it is, nevertheless, worthy of notice that 7.77 zirconia are a nearly full equivalent for 17.95 thorina, for the former contains 2.04, the thorina 2.12 oxygen. It might, therefore, be supposed that the thorina is replaced by zirconia in Edwardsite, which, however, cannot be assumed from the present view of their atomic composition, since, according to Berzelius, thorina is expressed by Th + 0, zirconia by 2 Zr + 3O. The tin in Monazite is evidently accidental from its minuteness, but remarkably enough, as Rose remarks, he found it also in Edwardsite, by means of the blow-pipe. If the presence of zirconia in Edwardsite be confirmed, and its isomorphy with thorina, then these two minerals can only be separated as species; if not, then both will probably agree in their chemical composition; in which case, it will be more proper to retain the name Monazite, which it first received.

Civil Engineering.

On the most Economical Angle of Splay for the Wing Walls of Culverts and Bridges. *By* Ellwood Morris, *Civil Engineer.*

The immense number of bridges and culverts required upon our Public

* There is evidently some error in the figures of this analysis, for the sum of those given is 101.49.

Works, renders it a matter of no small importance, that the most economical figure should be given to these structures.

It is true that occasionally the physical character of the site absolutely fixes the direction of the walls, but such cases are so rare as to form merely exceptions, and ought not to prevent the adoption of a general rule.

In constructing a Culvert, economy demands not only that the water way should be duly proportioned to the stream, and that the length of the Culvert be just sufficient to receive the embankment of the work; but also that its parapets should be of a certain size, and the wing walls splayed at a given angle.

For it can be demonstrated, 1st. That the most economical Culvert is that *which shows the least face*, or, other things being equal, has the lowest parapet. And 2nd. That there is *a certain angle of splay*, which requires less masonry in the wings than any other. The first branch of this subject it is not now proposed to enter upon, though we may remark, in passing, that to form the most economical, (and in point of fact also the most stable,) parapet, the coping of the Culvert should rest immediately upon the Keystone of the arch. And if there be any two culverts of the same water-way and splay of wing, one of which is *short* and has high parapets, whilst the other is *long* with low ones; the latter will contain far less masonry than the former.

To resume our subject. The main purpose of wing walls is to retain the embankment from obstructing the opening of culverts or bridges, though in culverts, they ought also to be so disposed as to aid the parapet in sustaining the end pressure of the embankment: fortunately, the most economical angle of splay (as we shall see hereafter) places the wings of culverts in a position highly suitable to subserve this object.

In these investigations we shall suppose the axis of the culvert or bridge to cross the line of direction of the embankment at right angles, and the *angle of Splay* to be the external angle, formed with the axis by the line of the wing produced; we shall also consider the height of the wing corner to to be always such, that the curve of the foot of the embankment running around it at the proper slope shall, at the level of the culvert floor, be tangent to the prolongation of the abutment face; that the whole structure rests upon a horizontal plane, passed through the floor of the water way; that the faces of the wings are right lines; and finally, we shall (for the present) treat the wing walls as though they were planes without thickness.

Thus in the plan, figure 1, let
A B = The axis of a Bridge (under superstructure.)
C C = Centre line of the Embankment.
A F D or A F E = Angles of Splay.
E G H I and D K = The Bridge Abutments and Wings.
E G and H I = Wing Walls.
M N = The top width of the Embankment.
L M and N O = The plans of the two Slopes.
1, 2, 3, 4, = The Embankment cones formed by training the material around the wing corners with the Embankment Slope.

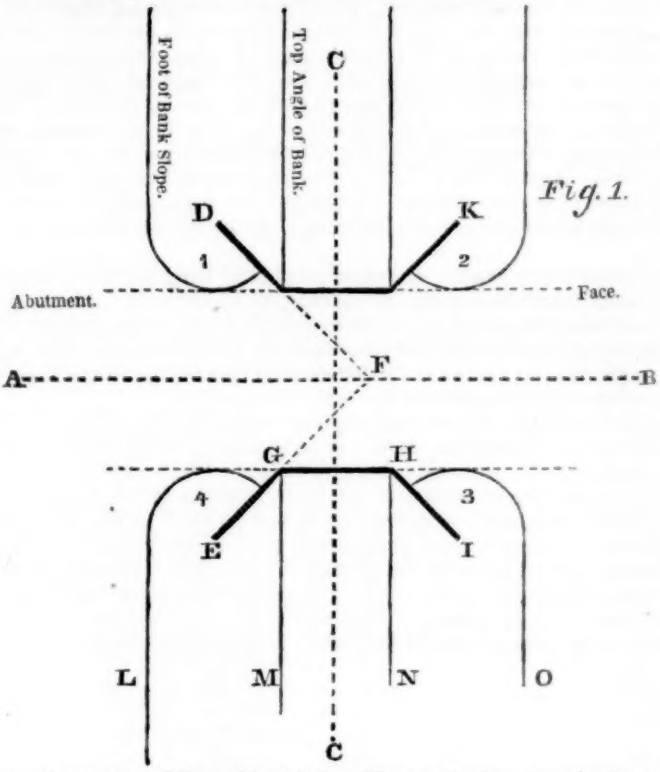


Fig. 1.

From the nature of the subject, it is evident that when the wing is parallel to the line of direction of the embankment, or the *Angle of Splay* is 90°, the figure of the wing wall will be a parallelogram; that when it is perpendicular to the line of direction, or parallel to the axis, the *Splay Angle* being = 0°, the face of the wing will present a triangle: and at any angle between these two positions, the surface of any wing wall will exhibit a trapezoid.

And it is further evident that when the wing is parallel to the line of bank, or when its face is a parallelogram, the surface is a *maximum:* now as the triangular wing is not that of the least surface, the question resolves itself into finding by the principles of maxima and minima, that wing amongst the trapezoidal forms, whose face shall be a *minimum.*

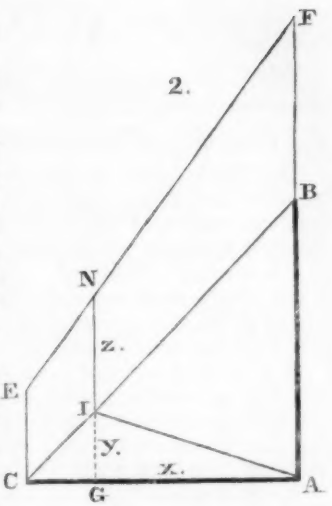
In figure 2, let

A B = A Wing Wall parallel to the bank, *Splay Angle* 90°.

A C = A Wing Wall parallel to the axis, *Splay Angle* 0°. Both being represented in plan.

Join B C, then will A be the origin of every possible wing wall, and the line B C the terminating or corner line of all, which satisfies the prescribed condition of just retaining the embankment from obstructing the water way. The height of the corner B of the parallelogram wing A B = *height of Bank*. And the altitude of the corner C of the triangle wing A C = 0.

Hence the *mean height* of the wing wall on the line A B = the height of the bank: on the line A C = one-half of that height: and in the trapezoidal forms the average heights of the walls, will be more than *one half* but less than the *whole* height of the bank.



Now prolong A B to F and make B F equal to the embankment height, and from C parallel to A B draw C E, and make it equal to one-half of the altitude of the embankment: join E F: then any line as I N drawn between the lines B C and F E, parallel to A F or C E, will represent the mean height of the wing wall whose base is the line I A, drawn from the intersection I, upon the corner line, to the origin A. And as the mean altitude of a trapezoid, multiplied by its length, is equal to the area, we have only to find the *Angle of Splay* G A I, such that the rectangle of any two lines, related like A I and I N, shall be a *minimum*.

Let us now consider the embankment slopes; A B or A C represents the base of a slope of which the altitude is B F (that of the bank.)

Therefore (figure 2) let

r = The slope ratio or the base to a rise of unity.

x = The abscissa A G of any wing wall.

y = The corresponding ordinate G I.

z = Any height line as I N.

Then

$$\text{When } x = 0\ z = \text{A B} \div r = y \times \frac{1}{r} = \frac{y}{r} = \text{B F}$$

$$\text{When } y = 0\ z = \frac{\text{A C}}{2} \div r = \tfrac{1}{2}x \times \frac{1}{r} = \frac{\tfrac{1}{2}x}{r} = \text{C E}.$$

Therefore generally,

$$z \text{ or I N} = \frac{\tfrac{1}{2}x + y}{r}$$

The base of any wing or the length of any line such as A I,

$$\text{Being manifestly} = \sqrt{x^2 + y^2}.$$

Consequently the general formula representing the area of any wing wall whose base lies in the angle B A C, is,

$$\left(\frac{\frac{1}{2}x + y}{r}\sqrt{x^2 + y^2}\right) = \text{Area.}$$

Treating this equation* by the principles of maxima and minima, we find the *minimum area* to have place when

The Tangent of the Splay Angle C A I $= \frac{1}{3}$ or the *Angle of Splay* $= 18° 26'$.

This angle (see C A I, fig. 2, which is drawn $= 18° 26'$) gives for the direction of culvert wing walls such a position as enables them to perform the important office of sustaining the parapet (against the outward thrust of the bank, which takes place in the direction A C,) besides containing a minimum surface:—In ordinary bridge abutments it is not often a matter of any importance in what direction the wing splays; and hence no reason of moment has occurred to the writer why a splay angle near $18° 26'$ might not be generally adopted.

Such is the theoretical deduction, supposing the wing walls to be planes, but in actual practice, owing to a portion of the wing being intercepted by the thickness of the abutment or parapet, the minimum wing in *cubic content*, has seldom a splay angle of *exactly* $18° 26'$, but the above investigation points out the limit which should be approximated.

To fulfil precisely the conditions required by economy, it is important that the splay of the face of the wings should originate in the abutment corner, and not, as is usual in Culverts, at some two or three feet from the face of the abutment. This plan of returning the abutment the length of the ringstone or more, has arisen from two reasons, first, with the view of securing a firmer bond of the wing and parapet back of the spandrel; and secondly, to improve the facade by displaying the whole front of the arch.

The former condition (that of solidity) we believe can, with little difficulty, be secured with wings originating at the abutment corner; and the latter being merely a matter of taste is not of paramount importance. With regard to bridge abutments no objection can be urged against splaying the wings from the abutment corners, that being the usual method.

We will conclude by subjoining a table showing the cubic content (at various splays) of *one wing*, both of a Bridge abutment and Culvert; supposing the mean thickness to be five feet: the abutment of bridge and parapet of Culvert same thickness, the altitude of each above the horizontal plane twenty feet, and all plumb both front and rear.

Also supposing the bridge wing to end in a vertical plane perpendicular to the abutment at five feet from the corner, or in fact (for the sake of comparison) including in each five feet lineal of the abutment; whilst the culvert wing is supposed to terminate in a vertical plane passed perpendicular to the parapet through its face angle of junction with the wing.

All answering the condition prescribed for wings, the slope of the embankment being assumed at $1\frac{1}{2}$ to 1.

* I have omitted the work of reducing this expression, as the result can be easily verified by any one acquainted with the first principles of the calculus.

Table of Wing Contents.

No.	Splay. Angle of Splay.	Splay. Tangt. of angle to a rad. of unity.	Length of wings on the front line.	Bridge abutment wings. Solid contents.	Culvert wings. Solid contents.	Face areas of one wing of each.	Dimensions common to both. Depression of wing cor.	Dimensions common to both. Dist. out of wing corner.
	Degrees and Minutes.	Feet.	Feet lineal.	Perches.	Perches.	Feet superficial.	Feet Lineal.	Feet Lineal.
1	0° 0′	0	30	80.	80.	300.	—20.	30.
2	11° 19′	$\frac{1}{5}$	23.72	77.92	76.32	297.5	—16$\frac{2}{3}$	25.
3	14° 02′	$\frac{1}{4}$	24.74	77.40	75.48	296.8	—16.	24.
4	18° 26′	$\frac{1}{3}$	25.49	76.68	74.32	296.5	—15.	22.5
5	26° 34′	$\frac{1}{2}$	22.36	75.72	72.80	298.2	—13$\frac{1}{3}$	20.
6	45°	1	21.21	76.40	73.12	318.1	—10.	15.
7	63° 26′	2	22.36	85.60	80.28	374.	— 6$\frac{2}{3}$	10.
8	71° 34′	3	23.72	89.52	87.16	415.1	— 5.	7.5
9	75° 58′	4	24.74	94.24	92.32	445.3	— 4.	6.
10	78° 41′	5	25.49	97.76	96.12	580.	— 3$\frac{1}{3}$	5.
11	90°	Infinite	30.	120.	120.	600.	0.	0.

In consequence of the thickness of abutment, or parapet, intercepting a portion of the wing wall, and modifying the theoretical result, it will be perceived by the table that although No. 4, whose splay angle is 18° 26′ has a *minimum surface*,

Yet No. 5 with an angle of splay of 26° 34′* has a *minimum capacity*.

We may also observe that taking the greatest and least wings and multiplying them by four (the usual number,) we have for their difference as follows:

Wings of Bridge Abutments.

4 wings, such as	No. 11. - -	480. Perches.
Do.	do. No. 5. - -	302.88 "
Difference in one bridge of the assumed dimensions		177,12 "

Wings of Culverts.

4 wings, such as	No. 11. - -	480. perches.
Do.	do. No. 5. - -	291.2 "
Difference in one culvert of the assumed size,		188.8 "

From the above we may deduce this practical inference, that when economy is desirable,

The splay angle of the wing walls of bridge abutments and culverts, ought not to be less than 18° 26′, *nor more than* 45°.

Though between these limits, the Angle of splay may vary without ma-

* This Splay Angle of 26° 34′ is that prescribed in some of the specifications for culverts upon the Chesapeake and Ohio Canal, drawn up by the present Chief Engineer, and recently in force on that work.

terial loss, and *the thinner* the wing wall, *the closer* will it approximate to No. 4 of the table, the theoretical minimum:

Oldtown, Md. April 26th, 1840.

Franklin Institute.

Sixty-fifth Quarterly Report of the Board of Managers of the Franklin Institute, of the State of Pennsylvania, for the promotion of the Mechanic Arts.

The Board of Managers respectfully submit to the members of the Franklin Institute their quarterly report.

The lectures of the Institute were closed on the 25th of March, after a session of much interest. In addition to the regular courses upon Chemistry, Natural Philosophy and Technology, by Professors J. K. Mitchell, J. C. Cresson and J. C. Booth, several volunteer lectures were given by J. F. Frazer, Esq., on Geology, and by J. S. Silver, Esq., on the Anthracite region of Pennsylvania.

To these gentlemen the thanks of the Board are tendered, for their efficient services in promoting the usefulness of the Institute, and the hope is indulged that we may be favoured next season with a more extended series of voluntary contributions.

Much to the regret of the Board, and disappointment of the numerous applicants, the drawing school was closed during the early part of the winter, in consequence of the protracted illness of Mr. William Mason; arrangements were, however, made for opening the school under the charge of Mr. Mason's Son, Mr. S. R. Mason, in time for the completion of one quarter, and it has been conducted by him in a manner entirely satisfactory. The number of scholars in attendance was 41.

The Library continues to increase by donations, by purchase and exchanges with the Journal. The additions from the latter source are numerous, and it is believed, may become still more important as a knowledge of the value of our Journal is extended at home and abroad.

For the promotion of this desirable object, the Board would urge upon the members of the Institute, the propriety of contributing more freely to its pages. Among the thousands who are partaking of the benefits of the Institute, there are many who possess the kind of knowledge which is peculiarly appropriate to our volume. Practical observations upon matters of daily or occasional experience, new processes, and convenient arrangements in the arts, the success or failure of experiments, and a great variety of similar material which is abundantly possessed by our members, would add much to the interest of the journal, and be highly creditable to the contributors.

The cabinets of models and minerals have both received valuable additions during the quarter, and the Committees who have them in charge have completed their arrangement.

A desire having been expressed by some of those who are most deeply interested that an exhibition of domestic manufactures should be held this year, the Committee on Premiums and Exhibitions, are taking the preliminary steps, and will shortly announce to the public, the progress of their arrangements.

The monthly conversation meetings, are sustained with much spirit, and appear to be increasing in favour with our members.

It should be borne in mind that the continued interest of these meetings must depend upon the zeal and readiness of our members, in providing the proper materials for their support.

The Committee on Science and the Arts continue their useful labours, and have reported upon several inventions submitted for their judgment.

For the information of members and others interested in the affairs of the Institute, the Board has directed the printing in pamphlet form, the Constitution, By-laws, and arrangement of the Committees of the Institute. The preparation for the press is completed, and when printed it will be placed at the disposal of members.

In addition to the usual standing Committees, the Board has recently constituted another, styled the Committee on the Cabinet of Arts and Manufactures, whose duties will consist in the collection and preservation of specimens designed to exhibit the past and progressive condition of the arts, which must become in time a source not only of much gratification to the inquisitive, but of useful instruction and historical interest.

During the past quarter, twenty-seven new members have been elected, and eight members have resigned their memberships.

The following gentlemen have become life members:—

Thomas Mellor, James Christy, Thomas Firth, and William D. Parrish.

The Treasurer's report is herewith presented.

JOHN C. CRESSON, Chairman.

WILLIAM HAMILTON, Actuary.

April 15th, 1840.

COMMITTEE ON SCIENCE AND THE ARTS.

Report on Dr. Rhoads' Maps for the Blind.

The Committee on Science and the Arts, constituted by the Franklin Institute of the State of Pennsylvania, for the promotion of the Mechanic Arts, to whom was referred for examination a new plan for making Maps for the Blind, by Dr. J. Rhoads, Principal of the Pennsylvania Institution for the Instruction of the Blind, REPORT:

That "various plans have been proposed and executed, from time to time, for making maps which the Blind can use by the touch. Of these, the greater part,—such as those which are embossed and printed in relief,—have to be made exclusively for the Blind, and are therefore either very expensive or very imperfect. A method, therefore, by which an ordinary map may be made sensible to the touch, must present a great advantage. Heretofore the only plan of this kind that can be considered successful, is to mark the lines, &c., by pricking the map through, from the back, with a point; a succession of burs is thus formed on the face, which may be distinguished by the fingers. This method is used only, (as is believed,) in the German Institutions and that in Philadelphia. It has the disadvantage of presenting but one kind of mark, and that this mark is subject to become blunted by use. Dr. Rhoads also uses a common map, and he makes it a tangible one, by the following process. Oceans, lakes, and bays are marked by covering the spaces with fish-glue and then spreading sand on it. When the glue hardens, the sand remains permanently attached. Rivers are marked by threads of cotton, formed into bundles of greater or less thickness, made to follow all the sinuosities of the engraving on the original

map, and fastened by fish-glue. When rivers are boundaries, however, they are distinguished by gluing a line of sand over the marks on the map. Artificial boundaries are marked by narrow strips of paste-board. Towns are marked by round pieces of paste-board,—or, by square pieces if they are capitals. Numbers, as printed in relief for the Blind, are fastened upon prominent points and places on the map, and give reference to a table at the side, in which the corresponding names are given, also printed in relief.

A map of this kind, the basis of which is Tanner's large map of the United States, is hung up in one of the rooms of the Institute, and enables the members to judge how well it accomplishes the object in view. To its other merits, it adds that of cheapness, as this map was executed by a young woman in ten days.

Dr. Rhoads' plan is equally applicable to globes, and he has made one of the kind for the use of his pupils.

Some of the members of the Committee have had frequent opportunities of seeing Dr. Rhoads' maps and globe, used by the blind, and can give evidence that they answer perfectly the purpose of their construction.

The Committee, in view of the various merits of this plan, have great satisfaction in making a decided report in its favour, and respectfully recommend it to the Board of Managers, as worthy of the Scott Legacy Premium.

By order of the Committee.

WILLIAM HAMILTON, Actuary.

Philadelphia, May 14th, 1840.

Report on a Coining Press at the United States Mint, Philadelphia.

The Committee on Science and the Arts constituted by the Franklin Institute of the State of Pennsylvania, for the promotion of the Mechanic Arts, to whom was referred for examination, the Coining Press recently put in operation at the United States Mint, in this City, REPORT:—

That, an early opportunity was taken to visit the Mint and examine the machine in question; of which the following description and historical notice has been kindly furnished to the Committee, by F. Peale, Esq., Chief Coiner, under whose direction the new coining machinery has been constructed.

This press resembles in general form, but differs considerably in detail from, the first one put into operation in the Mint in 1836, of which a short notice was published in the Journal of the Franklin Institute, (Vol. XVIII. No. 307.) The changes which have been made in it are the result of some years' experience, and by the adoption of which its operation has been materially improved.

Four fluted Doric columns of heavy proportions, stand upon a low pedestal, and support a table of cast iron upon which is placed the arch for sustaining the pressure, and the plummer blocks and other supports for the working parts of the press. This table and arch were planed, and are finished with as high a degree of polish as the metal is capable of receiving. The shaft receives motion by means of a pulley and strap from the Steam Engine, and is furnished with a loose pulley for suspending its operation. A crank upon the shaft gives motion through a connecting piece to the lever, the forward end of which forms a part of the toggle joint, by the action of which the pressure is given to the planchets. Upon the shaft at the side of the table is the fly wheel, constructed with a *friction hub* with

tightening screws, an important provision to prevent the injury that would inevitably occur from the accidental presence of two pieces between the dies, at the same time. Upon the shaft is also placed an eccentric with a metallic strap, furnished with a regulating screw moving a lever by means of which the feeding carriage is brought forward; during its advance, it raises, by inclined planes, the *stake* or block containing the lower die, to the level of the collar in which the piece is struck, and which is sustained by a *platform* connected with the arch of the press, at the proper time to permit the piece which has received its impression to be pushed off by the *feeders* which are advancing with a fresh planchet, after depositing which, they return and take the lowest from a pile contained in a tube placed upon the platform. The opening and closing of the feeders upon the planchets, is accomplished by a friction slide working in guide grooves in the platform. The upper die is held by adjusting screws in a pivoted triangular guide, whose socket supports the ball of the lower part of the toggle joint; this triangular guide, lower joint and part of the lever, are supported by a jointed *bridle*, having the same motion as the toggle joint, and connected by pivots with the arch of the press. The eccentric and lifters, last mentioned, are late improvements, which have materially added to the efficiency of this press, producing a smooth easy action, whilst the press is in operation at the rate of eighty-four revolutions per minute. The principal journals are oiled by syphon wicks in oil cups placed upon the caps of the boxes, in the classic form of small Etruscan vases.

The heavier parts of this press are of cast iron from the Foundry of Messrs. Merrick and Town, of this city, and are superior specimens of moulding and casting; the planing was also excellently executed in the establishment of these gentlemen. Many of the working parts, such as the lever and triangle, are of bronze, an alloy of copper and tin, in the proportions of nine of the former to one of the latter, being of a beautiful colour, working well, and retaining its lustre in an eminent degree, and for the above reasons deemed preferable to brass. The larger pieces were cast by the Messrs. Ames, at Cabotville, near Springfield, in Massachusetts, the smaller parts by Mr. Dyer of this city. The first named gentlemen, by their skill and care, have arrived at great perfection in this difficult art. Mr. Dyer also, by his perseverance, aided by free communication with the Messrs. Ames, has been very successful, and now furnishes castings of this alloy in every respect satisfactory.

All the small parts of the press are of steel, the heads of the screws and those parts exposed to friction, being hardened and tempered; the joints and fittings are executed with the greatest exactness and truth, and the whole has been finished to the highest possible degree.

We present the following note of the history of these presses.

In the "Bulletin de la Société d'encouragement, of June 1836, there appears a report by M. Francœur, on the coining press of M. Thonnelier of Paris, in which the merits of a press of similar principles, are warmly presented, and it is therein avowed that a press of the same character had been in successful operation at least eight years before in Munich, and that it is in the simplification and improvement of the German press, that M. Thonnelier has completely fulfilled the objects in view.

During a mission to Europe, for the Government, in 1834, for the purpose of investigating the various processes connected with Mint operations, Mr Peale was present at a trial of the press of M. Thonnelier in Paris, and also saw the German presses in operation in Carlsrhue, in the Grand Duchy

of Baden. After his return, a press upon similar principles was constructed for the Mint of the United States, and has been ever since in operation. Neither the German press nor the French improvement was satisfactory to Mr. Peale, and the result of his views and experience has been the construction of the press under consideration, with all possible care and attention, in the workshop of the Mint, and which has completely satisfied every anticipation and desire.

The rate of operation is as follows, eighty-four revolutions per minute enables the press to strike five thousand pieces per hour, leaving a short interval for the removal of the boxes containing the coin, cleaning, oiling, &c. This rate has been maintained for ten hours, the usual duration of a day's work at the Mint, which gives 50,000 pieces, but it is by no means the maximum, for satisfactory experiments have shown that one hundred pieces might be struck per minute; but the above rate has been adopted as the most advantageous, and at the same time sufficiently expeditious. It is scarcely necessary to add, that the attendance of one person is all that is required for this press, and that attention, and not personal labour, is all that is necessary to supply planchets and maintain it in proper order.

The press had been in operation during some weeks, and in that time had coined many hundred thousand pieces without a single accident, or the slightest evidence of a want of perfect accuracy of performance. Beside this individual machine, to which the attention of the Committee was especially directed, and which merits the highest admiration for its judicious arrangement, excellence of workmanship, and great beauty of finish, the Committee examined several other presses and milling engines, which manifest good taste and mechanical skill, in a degree but little inferior to this last specimen. The steam engine also which drives the presses, and some other machinery, exhibits the beau ideal of motive power, and while it appears to possess all the essentials for efficient action, has sufficient symmetry and cleanliness for a piece of parlour furniture. An occasional visit to the Mint, and examination of its machinery, would, it is believed, be of much benefit to master mechanics, by improving their taste for the beautiful, and by shewing them how great room for improvement in workmanship and neat arangement, exists in most manufacturing establishments. It may be added that the well known urbanity of the gentleman who has effected these excellent improvements, will insure an agreeable reception to all who may be inclined to avail themselves of this practical School of Arts.

By order of the Committee.

WILLIAM HAMILTON, Actuary.

Philadelphia, May 14th, 1840.

Notice of the Conversation Meeting of the Franklin Institute, held at the Hall, April 23, 1840.

The fifth Conversation Meeting of the season was held at the Hall of the Institute on the evening of Thursday, April 23rd. Among other objects of interest exhibited at this meeting, were a number of samples of castings from the foundry of Messrs. Savery & Co., which evince a great improvement in this important art; the flat and hollowware was almost as thin and as smooth as if made of sheet iron, and seemed perfectly sound and strong. A pair of cast fire irons from the same factory, had received a galvanizing coat of zinc and copper, by the process of Mr. T. Loring, to which

a polish had been given, equal in lustre, to burnished silver, said to be durable and cheap.

Mr. Thomas Loring, also exhibited several pieces of iron-tubing, covered with a protecting coating of the same alloy, upon which it is understood some experiments are now in progress, for the purpose of ascertaining its efficacy.

J. J. Mapes, Esq., of New York, editor of the *American Repertory*, shewed several specimens of Photographic portraits, executed by Mr. Walcott, of that city, which were much admired for strength of light.

Several beautiful portraits by the same process, executed by Mr. Robert Cornelius and Dr. Goddard, were exhibited by the latter gentleman. Mr. Joseph Saxton, produced a galvanic copy of a Photographic landscape, which, although manifestly imperfect, as the result of a first attempt, gives promise that these two novelties of science may be advantageously united. Professor Cresson gave a brief lecture on the continuance of vision, after the withdrawal of the visible object, which was illustrated by a modification of the Kaleidophone, on a large scale, and an instrument termed an ellipsarium, in which several luminous points are made to describe elliptical paths with sufficient speed to produce a permanent image of the whole path.

Much interest was excited by the exhibition of some specimens of the galvanic iris produced by the action of a galvanic current upon plates of polished steel, the specimens shewn were received by M. W. Baldwin, Esq. from Sir Michael Faraday. Mr. Baldwin gave an explanation of the process as witnessed by him at the Royal Institution, London.

The number of members and visiters present, was large, and the meeting one of considerable animation and interest.

Specifications of English Patents.

Specification of a patent granted to William Gossage, *of the county of Worcester, for his invention of certain improvements in manufacturing Iron.*—[Sealed 18th June, 1838.]

The method of converting pig, or crude, iron into malleable iron, by first melting the pig, or crude, iron in a furnace, called a "finery," and separating a considerable portion of the earthy impurities contained in such iron, and afterwards submitting the iron to the process called "puddling," and subsequently to the operation called "shingling," is well known.

It is also known to manufacturers of malleable iron, that during the operation called "shingling," as conducted in the above-mentioned method of converting pig, or crude, iron into malleable iron, a large quantity of black scoria, which is technically called "hammer slag," is separated from the metallic iron; and that this hammer slag consists of iron combined with oxygen, and is nearly free from earthy matter.

An improvement upon the above-mentioned method of converting pig or crude iron into malleable iron has been adopted, which improvement consists in using the hammer slag, obtained as before described, for the purpose of purifying pig or crude iron, and converting such iron into malleable iron by the operation called puddling, without the previous application of the finery process.

In working according to this improvement, hammer slag is put into the puddling furnace with pig or crude iron, in the first instance, and the oper-

ation of puddling then proceeds, according to a method well known; during which operation, a boiling up, or effervescence, takes place, and the earthy impurities become fluxed into cinder, which separates from the iron.

After the operation, called puddling, has been completed, the iron which has been separated is submitted to the process called shingling, in the same manner as is practised in working upon the old method, and a black scoria, which is also called hammer slag, is thereby separated from it; which hammer slag consists of iron combined with oxygen, but it also contains a considerable portion of earthy matters, which render this hammer slag unfit to be used for purifying pig or crude iron in the puddling furnace.

The manufacturer is therefore obliged to continue the finery process in part, in order to obtain hammer slag of suitable quality to be used for purifying pig or crude iron, in the puddling furnace, in the first instance.

I consider that the action of the hammer slag, used in the puddling furnace, as herein referred to, consists in furnishing oxygen, which disengages the carbon contained in the pig or crude iron, and in supplying oxide of iron, which, combining with earthy impurities contained in such pig or crude iron, forms the fusible compound called cinder.

One of the objects of my invention is to supply a cheap material, to be used as a substitute for hammer slag in puddling pig or crude iron. For this purpose I use the common argillaceous iron-stone, which is found generally in the coal districts of this country. This material contains oxide of iron, combined with carbonic acid, and by roasting or calcining it, in the ordinary method, I convert the carbonate of iron which it contains, into oxide of iron, and render the stone capable of being more easily reduced to powder. I then powder the calcined stone, and when this is powdered, it may be applied alone to the pig or crude iron in the puddling furnaces; but I prefer to mix the powdered stone with lime, in powder, either in the state of quick-lime or in the state of carbonate of lime.

The quantities of materials I usually employ for 450 pounds of pig or crude iron, of average quality, are 30 pounds of calcined iron-stone, and five pounds of slacked lime. I introduce the mixed powder into the puddling furnace, at the same time as the pig or crude iron, closing the damper of the furnace to prevent the powdery materials being carried off by the chimney draft. I then conduct the operation of puddling in the same manner as when hammer slag is employed.

As argillaceous iron-stone varies in the proportions of earthy matter and oxide of iron which it contains, so the quantity of this stone, required for purifying a given weight of pig or crude iron, will consequently vary. I find the proportions which I have stated, suitable when the iron which I use, contains from 40 to 50 per cent. of oxide of iron, and when this is applied to pig or crude iron of fair average quality. The proportion of lime required will vary according to the proportion of earthy matter contained in the pig or crude iron, and iron-stone respectively; but, as it is not customary for manufacturers of iron to investigate, with accuracy, the constitution of the pig or crude iron, or other materials which they employ, the most convenient mode will be to judge of the suitable proportions of iron-stone and lime by the progress of the operations. If the workman finds that the cinder produced does not become sufficiently fluid to separate freely from the malleable iron, he should increase the proportion of lime employed; and if the boiling up, or effervescence, which occurs during the puddling is not sufficient, he should increase the proportion

of iron-stone employed; but it will be understood that these last-mentioned directions are intended to apply only to subsequent operations, and that it will not be necessary, in any instance, to vary the proportions of any of the ingredients employed after the operation of puddling has been commenced.

My improvements, in the manufacture of iron, also consist in the construction of a more durable sole for the furnaces employed in the operation of puddling. In the furnaces usually employed for this purpose, the sole is a plate of cast iron, which is protected from the action of the fire by hammer slag and iron scale; but, instead of a sole of cast iron, which requires this protection, I use a sole of such grit stone as possesses the quality of resisting the action of fire. The stone which is usually employed for forming the hearths of iron smelting furnaces is suitable for the above purpose. I make this sole with either one entire block of stone, or with several blocks fitted together without cement.

I construct the sole in a form similar to that of the puddling furnaces now in use, to provide for running off the cinder, and I cause it to be sufficiently dished, or hollowed out, to retain the cinder without allowing it to come in contact with the walls of the furnace. I prefer that the sole should not be less than nine inches thick in any part; and as the furnaces will be similar to those now in use, in all respects, except as above described, I do not consider it necessary to give any further description of them.

The qualities required in the material used for constructing the furnace sole, according to my improvements, are a capability of enduring the action of fire, and such compactness and hardness as will best resist the chemical action of the fluxes to which the sole will be exposed in puddling iron, and which qualities are found in the grit stones used for the hearth stones in blast furnaces.

Having now described the nature of my said improvements, and the mode of carrying the same into effect, I claim as my invention, the use of argillaceous iron-stone in the conversion of pig or crude iron into malleable iron, by the process called puddling, whether this argillaceous iron stone be used with lime or other fluxing materials, or be used alone. And I claim the use of lime as a fluxing material, when used with any kind of iron-stone, or oxide of iron, in the conversion of pig or crude iron into malleable iron, by the process called puddling. And I claim, lastly, the use of such kind of stone, as I have herein described, for constructing the soles of furnaces for puddling iron.

Jour. Arts & Science.

Specification of a patent granted to MATTHEW UZIELLI, *of the city of London, for improvements in the modes of Impregnating Wood or Timber with Chemical materials.*—[Sealed September 4, 1839.

To all to whom these presents shall come, &c. &c.—*Now know ye*, that in complianee with the said proviso, I, the said Matthew Uzielli, do hereby declare the nature of the said invention, and the manner in which the same is to be performed, are fully described and ascertained in and by the following statement thereof (that is to say):—

The improvements in impregnating wood or timber are performed by calling into play a natural power which will be found to exist in trees recently felled, and which causes the introduction into all parts of their substance of any liquid in which their lower extremities are immersed a few

inches. The most favourable time to proceed to this preparation, is when the circulation of the sap is most active, and when trees are most covered with leaves. Experience has proved that the circulation has sufficient energy to produce the most satisfactory results during the months of May, June, July, August, and September, in certain species of trees it continues in October and November; pine and fir belong to the latter. Preservative liquids, and others can be applied in whatever position the tree is placed, by steeping its foot in a vessel containing the liquor it is desired to impregnate the timber with. But as a great expense of manual labour can be avoided by preparing the trees when lying down, their preparation ought to be proceeded with, by adapting (as soon as possible after they are hewed down) to their lower extremity an apparatus in the shape of a bag, made of water-proof cloth answering as a reservoir, which is constantly kept full of the liquid to be absorbed. The greater the number of limbs and of leaves left upon the tree, and the sooner the operation takes place after it is cut down, the surer and more complete the penetration will be, yet the possibility of introducing the liquid to a considerable extent has been ascertained, even after several days had elapsed since the tree was felled and had been deprived of its limbs. It is important that this circumstance should be known, for in many instances it may serve to avoid operating on the spot, and permit the establishment of central depots for the preparation. The time required for the operation seldom exceeds ten days, its duration depends on the vigor of the tree, on its species, on its age,and on the season of the year. Of all the matters which have been introduced into timber by the mode pointed out above, those which deserve the preference for its preservation are the unrefined pyrolignites (acetates) of iron and copper. All their elements, among which is creosote, are already known as good preservatives, and their cost, particularly that of the first named, is very trifling. Though a decided preference is given to these salts, great reliance can be placed in others; amongst them chloride of sodium (common salt) and arsenious acid (white arsenic) are to be particularly noticed; pieces of timber prepared with these substances have been submitted to powerful causes of alteration, and it has already been possible to ascertain that their protecting effect is very remarkable. To lesson the inflammability, and particularly the combustibility of timber, it is to be impregnated with chloride of sodium (common salt,) or with what is still better, a concentrated solution of chloride of calcium (muriate of lime,) shewing twelve degrees by Baume's areometer. The peculiar quality of rendering timber impermeable to moisture, is obtained by the introduction of resins dissolved, either in spirits of turpentine or in alcohol or pyroxylic spirits (wood-spirit, wood-naptha,) the same dissolvents permit the introduction of camphor and all essential oils.

Finally. Valuable colours can be given to white wood by penetrating it with sulphate of indigo, or a solution of pernambuco wood. The warping of wood has always been prevented by the introduction of chloride of sodium (common salt) or of chloride of calcium (muriate of lime.) I would remark that I do not confine myself to any particular solution for impregnating timber or wood; the invention secured by the present letters patent, not depending on the materials it is desired to impregnate the timber or wood with, but to the mode of applying it to wood or timber in such manner as to take advantage of the natural circulation, thus rendering the employment of very large tanks unnecessary, as only the lower ends of trees or timber are required to be immersed in the liquor.

Specification of a patent granted to WILLIAM HAWES, *for improvements in the manufacturing of soap; parts of which improvements are applicable to preparing tallow for the manufacture of candles.*—Sealed 12th June, 1839.

This invention is for a method of obtaining saponification, by mechanical means, instead of boiling the tallow or other fatty materials with the alkaline leys, as in the ordinary process of soap making.

An upright shaft, having radial arms affixed thereto, is placed or mounted in the boiler, or other vessel containing the tallow or other fatty materials, and is caused to revolve by any suitable mechanical contrivance. Upon the upright shaft being put in motion, the alkaline ley is poured in slowly, and a perfect incorporation of the ingredients takes place, by means of the radial arms on the upright shaft. Other mechanical contrivances may be adopted to cause the required admixture of the materials, but the patentee prefers the one mentioned.

The tallow in the boiler is to be kept at as low a temperature as is compatible with its remaining in a state of fluidity. No alteration in the proportions of the ingredients is required; and it is easy to ascertain when saponification takes place, as the ingredients begin to thicken directly after it commences.

The same mechanical contrivance is used for producing the saponification of tallow for the manufacture of candles. The cream of lime used in this process being added gradually in the same manner as the alkaline ley in the manufacture of soap. The fatty materials do not require boiling in these processes, but are kept dissolved at a low temperature by the application of a gentle heat.

The patentee claims producing saponification by mechanical means, without submitting the materials to the boiling process.

Jour. Arts & Science.

Specification of a patent granted to WILLIAM HOLME HEGINBOTHAM, *of the county of Chester, for his invention of certain improvements in the construction of gas retorts.*—[Sealed 31st January, 1838.]

These improvements in the construction of gas retorts consist, firstly, in the introduction of an apparatus into the body of the retort in ordinary use for the distillation of coal, for the purpose of propelling the coal through the retort, and discharging the coke from the same after carbonization. This apparatus is composed of a central shaft passing entirely through the retort, around which shaft is formed a worm or screw, for the purpose of dividing the interior of the retort into helical partitions or chambers, and thus more effectually exposing the coal under process of decomposition to the action of the heated surfaces of the retort; and, secondly, in the application of rotary motion to this helical worm or creeper, in order to cause it to propel the coal through the retort and keep it in constant motion; thus constituting a self-acting gas generator, capable of feeding and discharging itself without the necessity of removing the mouth-piece of the retort, and exposing its interior surface to the action of the atmosphere.

This peculiar combination of apparatus will be found to effect the most perfect decomposition of coal, and, at the same time, to improve the quantity and quality of gas produced, as it will be evident that the revolution of the worm shaft in the bed of the heated retort (and of an uniform heat with it) passing progressively through the coal under operation, and at the same

time working or advancing it from one end of the retort to the other, will effect a most perfect and rapid distillation; while the gas evolved will become, as it were, filtered and improved, being freed from tar while effecting its passage to the exit or ascending pipe at the discharging end of the retort.

Another considerable improvement is effected by the revolution of the worm, as it will entirely prevent the interior of the casing or retort from becoming encrusted with coke or other matter to which it is usually subject, thus rendering it more durable; and it will always ensure an uniform regularity in the supply of coal simultaneously with the discharge of coke, and also that no coke will remain in the retort after it has become carbonized. I have attached to these improvements an apparatus to crush or grind the coal prior to its introduction into the improved retort, as its peculiar construction enables me to generate gas from pulverised coal, and, consequently, to produce it at a much less cost. (Figures representing the improved retorts may be seen in Newton's London Journal for February.)

Ibid.

Progress of Practical and Theoretical Mechanics and Chemistry.

Among the works recently received by the Institute from abroad, is a small volume presented by William Vaughan, Esq., of London; entitled, *Arts and Artisans at Home and Abroad: with sketches of the progress of Foreign manufactures. By* Jelinger C. Symons, Esq., *one of the assistant Commissioners on the hand-loom inquiry, &c.*

The subject of this treatise is so germain to the objects of the Institute, and so well calculated to interest the readers of its journal, that we shall from time to time insert copious extracts of the matter of fact details which it contains, and occasionally give the opinions of the author; without, however, any design to subscribe to his views of national policy.

The rates of wages and price of provisions are given in the currency of the nations whose manufactures are examined, and it is deemed proper to leave these unchanged; merely premising that the conversion into federal currency is attained with sufficient accuracy by assuming the penny sterling, (*d.*) equal to two cents; the shilling (*s.*) will consequently be 24 cents, and the pound sterling (*l.*) will be $4,80.

The Franc of the French, (fr.) is nearly 20 cents, the centime (cent.) being the $\frac{1}{100}$ of a franc will equal two mills.

The Florin, (Fl.) is about 40 cents, and the Kreutzen, (Kr.) is $\frac{1}{60}$ of the florin or about $\frac{2}{3}$ of a cent. Com. Pub.

Wages at Home.

I shall first endeavor to exhibit the exact differences between the rates of wages here and abroad, both as regards their pecuniary and real value. I will begin with this country; and having given a summary sketch of the average wages of journeymen, current in the chief branches of industry here, I shall proceed to detail more circumstantially the wages paid to the same artisans in some of the chief nations of the Continent. I believe, allowing for the fluctuations of trade, the following statement will be found sufficiently accurate for the purposes of comparison.

The following rates of wages in the Lancashire Factories are nearly an

average for the whole country, and were drawn up by the Manchester Chamber of Commerce:

Spinners, men,	20*s*	to 25*s*
Spinners, women,	10*s*	15*s*
Stretchers,	25*s*	26*s*
Piecers, (boys and girls,)	4*s* 7*d*	7*s*
Scavengers,	1*s* 6*d*	2*s* 8*d*
In the Card room:		
Men,	14*s* 6*d*	17*s*
Young women,	9*s*	9*s* 6*d*
Children,	6*s*	7*s*
Throstle spinners,	5*s*	9*s* 6*d*
Reelers,	7*s*	9*s*
Weavers by Power:		
Men,	13*s*	16*s* 10*d*
Women,	8*s*	12*s*
Dressers, men,	28*s*	30*s*
Winders and warpers,	8*s*	11*s*
Mechanics,	24*s*	26*s*

Weaving by Hand:

Quality	Woven by		
Nankeens, fancy,	men,	9*s*	15*s*
" common,	children & women,	6*s*	8*s*
" best,	men,	10*s*	13*s*
Checks, fancy,	men,	7*s*	7*s* 6*d*
" common,	children,	6*s*	7*s*
Cambrics,	all ages,	6*s*	6*s* 6*d*
Quiltings,	men and women,	9*s*	12*s*

In other trades, the following are about the average rates of wages paid throughout England:

Fustian cutters,	all ages,	10*s*	to 12*s*
Machine makers,	men,	26*s*	30*s*
Iron founders,	men,	28*s*	30s
Dyers and dressers,	men,	15*s*	20*s*
"	young men,	12*s*	14*s*
"	boys,	5*s*	10*s*
Tailors,	men,	18*s*	20*s*
Porters,	"	14*s*	16*s*
Shoemakers,	"	15*s*	18*s*
Whitesmiths,	"	22*s*	24*s*
Sawyers,	"	24*s*	28*s*
Carpenters,	"	20*s*	25*s*
Stone-masons,	"	18*s*	22*s*
Bricklayers,	"	17*s*	20*s*
Bricklayers' labourers,	"	12*s*	
Painters,	"	18*s*	
Slaters,	"	3*s* 8*d* per day.	
Plasterers,	"	19*s*	to 21*s*
Spadesmen,	"	10*s*	15*s*
Blacksmiths,	"	18*s*	22*s*
Compositors,	"	24*s*	

Wages in Sheffield vary from 25*s.* to 35*s.* per week for the workmen in the skilled departments and often amount to 40*s* per week.

In the iron-works in the Birmingham district, wages average from 20*s.* to 30*s* for the common labourers, so great is the increasing demand in the iron trade.

In the Leeds flax-mills the wages average as follows:—Male adults, from 17*s* to 19*s* per week; females from 5*s.* 6*d.* to 6*s.* 6*d*; children between nine and ten years old, 3*s.* 6*d.* to 4*s.*

In the Gloucestershire cloth-factories, the wages of male adults average from 12*s.* to 14*s.*; of females, from 4*s.* to 5*s.*, and of children, from 2*s.* to 3*s* 6d.

To these I may add the following statements as regards Scotland, where my inquiries were personally applied.

In and near Glasgow, masons, bricklayers, house-carpenters, blacksmiths, &c., earn from 19*s.* to 22*s.* per week. Engineers from 20*s.* to 30*s.*, according to skill, &c.; and some higher. Tailors, cabinet-makers, hatters, plumbers, shoemakers, &c., earn from 20*s* to 25*s.* In the country the wages are lower by 10 to 20 per cent. In the cotton-mills the following may be taken as a fair general average:

			Per week.
Picking room,	females	20 years of age and upwards,	7*s*
Attending cards,	males and females,	13 years to 15,	4*s* 6*d*
"	drawing frames,	females, 16 years and upwards,	6*s* 6*d*
"	slobbing frames,	do. do.	6*s* 6*d*
"	finishers,	do. do.	7*s*
"	stretchers,	do. do.	8*s* 6*d*
"	throstle spinners,	do. 13 years and upwards,	7*s*
"	reelers,	do. 16 years and upwards,	6*s* 6*d*
"	toppers,	males, 20 years and upwards,	14*s*
"	spinners,	do. do.	25*s* to 29*s*
"	outside piecers,	do. 16 years to 20	6*s*
"	inside piecers,	do. 13 years to 16	3*s* 6*d*
"	cleaners,	do. 9 years to 13	2*s*

In Lancashire, nearly the same distribution of labour prevails; but the average rate of wages, including men, women, and children, indiscriminately, amounts weekly to 10*s.* 6*d.* per head.

In the collieries, the following table affords a views of the variations which have taken place in wages since 1811; and as no trade has been more subject to combinations, or exhibited more important peculiar features, I do not hesitate to introduce it. I am indebted to William Dixon, Esq., one of the largest proprietors of collieries in Great Britain, for the information it contains.

	Average earnings per day.			Average Earnings per week, assuming 4½ days of 10 hours as the average quantity of work wrought by each collier per week, with house free, and coal free, except his own labour in producing it.			Total earnings per week, including house-rent, which is given gratis, and coals.		
	L.	S.	D.	L.	S.	D.	L.	S.	D.
1811	0	4	11	1	2	1½	1	4	8½
1812	0	4	11	1	2	1½	1	4	6½
1813	0	4	0	0	18	0	1	0	5
1814	0	4	3	0	19	1½	1	1	5½
1815	0	4	6	1	0	3	1	2	5
1816	0	4	7	1	0	7½	1	2	9
1817	0	4	0	0	18	0	0	19	11
1818	0	3	8	0	16	6	0	17	5
1819	0	3	11	0	17	7½	0	19	6½
1820	0	3	9	0	16	10½	0	18	9½
1821	0	3	3	0	14	7½	0	16	6½
1822	0	3	6	0	15	9	0	17	10
1823	0	3	7	0	16	1½	0	18	1½
1824	0	4	2	0	18	9	1	0	0
1825	0	5	3	1	3	7½	1	6	5½
1826	0	5	0	1	2	6	1	4	8
1827	0	4	3	0	19	1½	1	0	9½
1828	0	4	3	0	19	1½	1	0	11½
1829	0	4	3	0	19	1½	1	0	9½
1830	0	4	3	0	19	1½	1	0	11½
1831	0	3	11	0	17	7½	0	19	3½
1832	0	4	1	0	18	4½	1	0	0½
1833	0	4	0	0	18	0	0	19	8
1834	0	4	0	0	18	0	0	19	9
1835	0	4	0	0	18	0	0	19	9
1836	0	4	9	1	1	4½	1	3	8½
1837	0	5	0	1	2	6	1	5	0
1838	0	4	6	1	0	3	1	2	7
In July 1838	0	3	6	0	15	9	0	17	5

The stocking-makers of Leicester average, according to Mr. Porter's statement, 8*s.* 3*d.* per week. In Dumfries, celebrated for the excellency of this article of manufacture, the workmen are paid at so much per dozen of the fabric woven, whether stockings, drawers, or shirts. Men's stockings of 24 gage are paid 9*s.* 6*d.* per dozen, and an average workman will make 18 pair in the week; gross wages 14*s.* 3*d.* from which deductions for frame rent and seaming amount to 2*s.* 2*d.* leaving 12*s.* 1*d.* clear wages; and this may be considered an average rate of wages in this trade.

Almost all the above named trades are more or less combined.

Of those trades which are not combined, or where the unions, if existing at all, are inefficient, that of hand-loom-weaving is the chief.

In Scotland, which may be taken as a tolerably fair average of other parts of the kingdom, and where I found 51,000 hand-looms south of the Forth

and Clyde, the following is an outline of the average net wages earned on ginghams and pullicates, or checked handkerchiefs, and muslins, comprising a very great majority of the whole number of looms. The weavers earn from 4*s*. 6*d*. to 7*s*. net wages and by far the largest portion of them under 5*s* net, after the expenses they incur, varying from 1*s*. 2*d*. to 1*s*. 6*d*. are defrayed. On fancy muslins, silk gauzes, and the commoner description of shawls, employing a small number of looms, compared with the foregoing, the wages vary from 5*s*. to 8*s*. per week, net. On the finer description of Paisley and Edinburgh shawls, from 9*s*. to 14*s* are earned; but where fancy patterns, involving considerable complexity in the mountings of the loom, are required, it is hardly possible to fix an average. Great skill, and sometimes the success of a particular pattern in a market, capricious and uncertain like that of fashion, will afford the skilled weaver 20*s*., 25*s*., and 30*s* per week; but these may be almost regarded as prizes in a lottery, and are as little reducible to calculation. The woollen weavers, of whom there are but few, and those isolated in particular localities, are well paid in Scotland, earning from 10*s* to 20*s*. per week.

The woollen weavers work almost entirely in factories where the hand-looms are placed, belonging to the manufacturer; and I ought to have stated above, that in the few instances where this is the case with the ginghams, checks, and other cotton fabrics, the wages are invariably from 40 to 80 per cent higher. To this singular feature I shall have occasion to refer hereafter. I subjoin a table, shewing the extraordinary decline of hand-loom wages during the last thirty years, in one of the chief trades.

Pullicates and Ginghams.

Period.	Average net weekly wages.		Period.	Average net weekly wages.	
	1st Class.	2nd Class.		1st Class.	2nd Class.
1810 to 1816	17*s*	24*s* 6*d*	1830	6*s*	7*s* 6*d*
1816 to 1820	10*s*	13*s* 5*d*	1831	6*s*	7*s* 6*d*
1821	8*s* 6*d*	12*s* 2*d*	1832	5*s* 9*d*	7*s*
1822	9*s* 6*d*	12*s* 2*d*	1833	5*s* 3*d*	6*s* 6*d*
1823	9*s* 6*d*	12*s* 2*d*	1834	6*s* 6*d*	7*s* 3*d*
1824	9*s* 6*d*	12*s* 2*d*	1835	6*s* 8*d*	7*s* 9*d*
1825	7*s* 6*d*	10*s*	1836	5*s* 9*d*	7*s* 6*d*
1826	6*s* 6*d*	8*s* 2*d*	1837	4*s* 3*d*	6*s* 6*d*
1827	7*s* 6*d*	10*s*	1838	4*s* 6*d*	7*s*
1828	6*s* 6*d*	8*s* 5*d*	1839	5*s*	7*s* 6*d*
1829	6*s* 6*d*	8*s*			

Agricultural wages, which, though not strictly within the scope of my subject, I was at some pains to collect in Scotland; and as the following were derived almost exclusively from official sources, they may be worth recording, especially as the economy of agriculture in Scotland differs considerably from that of England.

I select some of the most important agricultural counties of Scotland.

"In *Kincardineshire*, married male servants are generally engaged by the year, from Whitsunday to Martinmas; and, in addition to the average

rate of wages, 12*l*: 12: 10 per annum, and 17½ lb. of oatmeal per week, they have, in most parts of the county, a house and garden, with, in some places, 1½ pint of new milk per day, or 4 gallons of new milk per week, 2 bolls of potatoes, or ground properly prepared, which will grow ¾ of a ton of potatoes, and ten barrels of coals. Where the employer gives the milk of a cow, the money wages may average 10*l*. 10*s*., and the other items are given him.

"The diet and other allowances given to the married male servant, exclusive of money-wages, have been estimated by intelligent agriculturists at 14*l*. to 16*l*. per annum.

"Unmarried male servants are generally engaged for the half year; and in most cases they have an allowance of 17½ lb. of oatmeal, and 3 gallons of new milk weekly, with a bed, and an apartment to cook in, and an allowance of fuel and light; or they get their victuals in the farmer's ouse.

"Board-wages for men are 3*s*. 6*d*. per week; and the diet, &c. exclusive of money-wages, have been estimated at 12*l*. 4*s*. 5*d*. per annum.

"Married female servants are very seldom engaged by the half-year: they are almost always engaged by the day, or at piece work, such as hand-hoeing of green crop, &c., and earn per day, without diet, 8*d*.; at hand-hoeing green crop, 1*s*.; and at harvest-work, 2*s*. 6*d*. per day at piece work.

"Unmarried female servants are generally hired by the half year, but are likewise hired by the whole year, at the average rate of 5*l*. 16*s*. 6*d*. per annum of wages, and are generally allowed washing, but not always.

"Board-wages for women are 2*s*. 6*d*. per week; and their diet, &c. exclusive of money-wages, have been estimated at 10*l*. 8*s*. 6*d*. per annum.

"Boys are hired as young as twelve years of age, and are reckoned boys until they can manage a pair of horses.

'Board-wages for boys are 2*s*. 6*d*. per week; and their diet, &c. exclusive of money-wages, have been estimated at 9*l*. 19*s*. per annum.

"Girls are not generally hired as agricultural labourers by the half year. They are employed as day-labourers, at 8*d*. per day, without diet. For hand-hoeing green crop, or hired as harvest-labourers, a girl of seventeen years of age will get the average rate of harvest-wages allowed to unmarried female servants.

"Board-wages for girls is 2*s*. per week; and their diet, &c. exclusive of money wages, have been estimated at 9*l*. 4*s*. 5*d*. per annum.

"The rate of wages given to day-labourers supposes an average rate for the year.

"The diet, &c. to harvest-labourers have been estimated for men at 1*l*. 17*s*. 6*d*., and for women at 1*l*. 13*s*. 9*d*., for six weeks.

"In *Dumfriesshire*, the wages of ploughmen average 1*s*. 6*d*. per day, with bacon, potatoes, oatmeal, and milk. Boys of twelve and upwards, 4*s*. Able-bodied men, wages per half year, 5*l*. 15*s*.; women, 2*l*. 15*s*., with board. Agricultural labourers, summer half year, 18*d*. per day of ten hours; winter half year, 15*d*. per daylight to dark, without victuals. Cottages and garden, 50*s*. per year.

"*Roxburghshire*, ordinary labourers, 10*s*. 6*d*.

"Hinds or ploughmen paid wholly in money, and including house-rent, 11*s*. 9½*d*.

"Hinds or ploughmen paid partly in money, and in kind, viz., portions

of meal, barley, and pease, potatoes planted, and cow maintained, and also including house rent, 12*s.* 5½*d.*

"Shepherds paid in kind, and also including house rent, 12*s.* 9½*d.*

"Women's wages, from first March to first December, 5*s.*

"Do. from first December to first March, 4*s.*

In *Perthshire*, ploughmen's wages for a twelvemonth, money, 13*l.*; 1 pint sweet milk per day, *a* 3*d.*, 4*l.* 11*s.* 3*d.*; two pecks oatmeal per week, *a* 1*s.*, 5*l.* 4*s.*, ... =22*l.* 15*s.* 3*d.*

"Lodging, say at the rate of 1*s.* per week, . . 2*l.* 12*s.* 0*d.*

25*l.* 7*s.* 3*d.*

"Day or week labourers are paid during the winter months at the rate of 8*s.* per week; and in summer, at the rate of 11*s.* per week; in all, say 24*l.* 14*s.*

"In *Fifeshire*, 1. An overseer who takes a small part in the manual labour of the farm, and at same time oversees and directs the other servants, earns 15*s.* 2*d* per week.

"2. A foreman or overseer who joins in all the manual labour, and at the same time directs the operations of the other servants on the farm under him, earns 11*s.* per week.

"3. Servants under any of the foregoing, who are married, and have a house and cow's grass, and other perquisites, earn 9*s.* 1*d.* per week.

"4. Servants who live in a bothie, furnished by the farmer, who have part meal, part money wages, with fire to make ready their victuals, 8*s.* 3*d.* per week.

"*Note.*—All farm servants are engaged to labour from six in the morning to six at night, and thereafter to feed and do up their horses.

"5. Workmen employed on farms making drains, scouring ditches, and others who have a fixed daily wage in money commonly called day labourers, 10*s* per week.

"*Note.*—This class of labourers work from six in the morning to six at night, but are frequently interrupted from work by inclement weather, particularly in winter, in which event they are only paid for the number of days or hours they are employed in working.

Agricultural wages in England vary so little and are so well known, that I need hardly do more than state that in the Cotswold districts, for instance, a shepherd receives 10*s.* weekly, a carter the same, day labourers 8*s.* in summer and six in winter, in addition to which, they earn about three guineas at harvest time, which will pay their rent. Women receive 6*d.* a day in winter, 8*d.* in summer, and 1*s.* in time of hay and harvest time. Perhaps these are the lowest wages paid in any district in England. From 8*s.* 6*d.* to 10*s.* 6*d.* will be throughout the average wages of the great bulk of adult male agricultural labourers of England.

As no estimate of mere pecuniary wages is of any practical use without a knowledge of their real value, I subjoin an average of the prices of provisions in the manufacturing districts of England and Scotland, which will be found as nearly correct as any general average can be made. It refers to the last two or three years *before* the recent rise of the price of grain.

England.

Best beef, per lb.	6*d.*	Coarse beef per lb. . .	3½*d.*
Bacon, . .	7*d.*	Bread flour, per 12 lb. .	2*s.* 6*d.*

Wheaten flour, per lb.	2*d.*	Cheese, . . .	7*d.*
Malt, per 9 lb. .	2*s.* 4*d.*	Potatoes, per 252 lb. .	3*s.* 6*d.*
Pork, per lb. .	6*d.*	Coals, p. ton (without carriage,)	10*s.* 6*d.*

In Scotland the following have been the average prices of meal, &c. in the last few years.

	1834.	1836.
Perthshire—		
Oatmeal, per boll of 140 lb.	14*s.* 5*d.*	21*s.* 5*d.*
Best wheat, per Imp. qr.	44*s.*	52*s.* 1*d.*
Edinburgh—		
Oatmeal, per boll,	11*s.* 10*d.*	17*s.* 2½*d.*
Best wheat, per Imp. qr.	40*s.* 8*d.*	54*s.*
Dumfries—		
Oatmeal, per boll,	13*s.* 6½*d.*	20*s.* 10*d.*
Best wheat, per Imp. qr.	40*s.* 10*d.*	52*s.* 10*d.*

Wages in Belgium, and Physical condition of the Artisans.

Having summarily sketched, in the foregoing pages, the rates and variations of wages in the chief departments of home industry, I shall, ere I offer any remark on the features they exhibit, proceed to give as detailed a view of wages on the Continent as the relative importance of each country requires. I may state, that by very far the greater part of these returns are derived from official sources, on which implicit reliance may be placed, and which I was at great pains to corroborate or correct by personal inquiries, with the facilities to which I have already alluded. The returns from Wirtumberg, Holland, and partially from Prussia, are mostly derived from the "foreign communications," collected by the Commissioners of Inquiry into the State of the Poor Laws, and of which I have availed myself, for the purpose of rendering the following sketch of continental wages as complete as it could be rendered. Unless otherwise stated, the period at which the wages were struck, is last year.

Owing to the great facilities afforded me through Her Majesty's minister at Brussels, and the introductions he kindly procured me, I am enabled to state the wages in Belgium with considerable detail; and I am bound, moreover, to tender my best acknowledgments to Monsieur Vandermaelen, the celebrated geographer and statist of Brussels, for his courteous and efficient aid. I need hardly add, that, from her peculiar territorial and maritime advantages, her mineral riches, and the laborious character of her artisans, and the enterprise of her manufacturers and merchants, Belgium is perhaps, of all other neighbouring countries, the one whose commercial and industrial progress is the most interesting to Englishmen.

The main sinew of Belgian prosperity is unquestionably her iron. I shall commence therefore, with the wages paid in the various departments of the iron manufacture.

One of the largest establishments in the world for the manufacture of machinery, is that of Mr. John Cockerill, of Seraing, who is, moreover, at the head of 53 distinct establishments, including mines, spinning and weaving factories, &c. At Seraing near Liege, 3000 workmen are employed. The wages are as follows:—The designers (dessinateurs) receive from 1500

to 2000 francs* per annum, or 60*l.* to 80*l.* The workmen are divided into brigades. There are 40 in the first process who earn from 3 to 4 fr. per day; the overseer is an Englishman with a fixed salary. The founders earn from 4 to 5 fr. per day. The nail-makers are 200 in number, chiefly very young men, who are paid per weight of nails, and earn from 3 to 4 fr., being responsible for losses. The manufacture of furnaces is very considerable, from 500 to 600 workmen are employed, earning from 4 to 5 fr.: this work is very laborious, and deafens most of the men. The forgers earn various wages; from 2.50 to 6 frs. In the higher skilled and more laborious departments, wages vary from 5 to 10 frs. per day. In the collateral workshops, all comprised in the establishment, there are 60 carpenters (model makers,) who earn 2 fr. 40 cent., also, leather workers, at from 2 to 3 fr. per day; the out-door carpenters earn the same. There are 500 turners in wood, brass, and iron, who earn, for the most part, from 2 to 3 fr. per day, and the older ones double. There are 400 fitters and filers, who earn from 2 to 3 fr. per day, and divide a perquisite of 70 florins according to the work they have done. The proving department (l'Atelier d'epreuve) is composed of the oldest and most experienced workmen, who earn from 4 to 5 fr. a day. The assistants mostly youths, earn from 1 fr. 50 cent. to 2 fr. per day. There are not above 6 or 7 English engineers now in the establishment, who earn from 10 to 15 fr. per day, and who are each superintendents of different departments.

The average wages of the adult workmen in this leviathan establishment, are about 3 fr. 50 cent. The others in Belgium may be taken at about 10 per cent. lower. The ordinary hours of labour are 11 per day. The *miners* gain as follows:—

The superintendents, -	2 fr. 30 cent. per day.
The first class workmen, -	2 fr. 25 cent. "
Second do. -	2 fr. 10 cent. "
Youths, - - -	1 fr. 90 cent. "
Do. under 12 - -	1 fr. 30 cent. "

Age of admission is 10 years. Period of work, usually six hours per day.

N. B. The food of these workmen is usually pork, and bacon, and potatoes. Coffee and gin are their ordinary beverage. The workmen on the surface earn from 2 fr. to 2 fr. 50 cent.

"The two pound loaf, of the quality of bread usually eaten by the lower classes at Brussels, costs 32 cent. (3½*d.*,) and it would probably be less dear elsewhere; from what I could learn at Liege, the expenses of living are little more than two-thirds of what they are at Brussels, but this may be attributed to the extreme cheapness of vegetables which form a principal article of consumption for the poor.

In cotton-spinning factories, the chief of which are at Ghent, the general rate of wages are—

For adult men, spinners, &c. from	2 fr. 50 cent. to 3 fr. per day.
For apprentices from 12 to 16, -	75 cent. to 1 fr. "
For girls, - - - -	75 cent. to 1 fr. "

*I shall use the money of the country; a franc is nearly equivalent to tenpence, and is divided into 100 centimes, of which every ten are worth about one penny. Twenty-five francs 25 centimes make a pound sterling.

The following are the wages which I struck from Mons. de Bast's factory:—

135 weavers were paid 1800 fr. per week for 14 hours' work per day, making an average of 13 fr. 33 cents, each per week.

In the spinning mill 143 persons are paid 1400 fr. per week, making an average of 9 fr. 79 cent. per week.

A good spinner will earn 24 fr. per week, out of which he has 7 fr. 50 cent. to pay to his piecer; spinners are paid 23 to 25 cent. (2¼*d.* to 2½*d.*) per kilogramme, 2⅕ lb.

During six months last year, Monsieur Bast's mill worked 1950 hours, or 13 hours daily, reckoning 150 working days in the half year. Just then I was assured they worked from 14 to 15 hours. However this may be, the people in the mills, especially the females, looked exceedingly well; and a gentleman who had seen mills in Scotland, and was with me, was also of opinion that the people in the Ghent mills looked quite as well as those he had seen in Scotland.

Another cotton spinner writes: "I have several spinners who employ an equal number of little girls, though the number will soon be augmented. These spinners gain about 17 fr. per week, out of which they have to pay 2 or 3 fr. to those children who assist them.

In the linen spinning factories the men are paid at the rate of 1 fr. 35 cent. for every 12 hours' work. No women are as yet employed in these factories, though the want of more hands will probably introduce them ere long. The children employed are about one-quarter the number of the men.

In the woollen spinning factories the wages are nearly the same as in the cotton factories.

In the dyeing establishments of forty work people, the following were the wages,

5	earned	2 fr.	20	cent.	per day.
15	"	1 fr.	80	"	"
5	"	1 fr.	60	"	"
5	"	1 fr.	40	"	"
5	"	1 fr.	20	"	"
5	"	0 fr.	80	"	"

No females are usually employed in these works.

The following is a summary of the rates of labour in town and country, in the other chief arts and trades:—

Trades.	Town Wages.	Country Wages.	Hours usually worked.
	fr. ct.	fr. ct.	
Masons, Carpenters, and Blacksmiths,	2 5	1 60	11½
Day-labourers, - -	1 35		11½
Saddlers, - - -	2 25		
Wheelwrights, - -	2 25		
Compositors, - -	3 0		
Lithographic Printers, -	5 0		
Cabinet Makers, - -	3 0		
Bleachers, - - -		2 0	16 in summer.
Taylors and Shoemakers,	2 50	1 60 or with food 75	11 to 12
Sawyers, - - -	3 25		
Forgers, - - -	6 0		
Coach Painters, - -	2 25		
Paviers, - - -	1 80		
Labourers at Canal wharfs,	1 70		
Miners, - - -		2 50	10

Agricultural labourers are paid as follows:—

Provinces.	Conditions.	Men.	Women.
		fr. ct.	fr. ct.
Brabrant,* - -	with food - -	0 63	0 31
Westpellier, -	without food -	0 91	0 80
West Flanders, -	with food - -		
	without food -	1 20	0 80
Liege, - -	with food - -	1 18	0 88
	without food -		
Luxemburg, -	with food - -		
	without food -	1 0	0 85

The wages of agricultural labourers vary considerably in East Flanders; they are still lower than in West Flanders, where there are more factories. In Liege and Namur, in the heart of the manufacturing district, agricultural wages are nearly double what they are in the purely agricultural provinces. In the province of Liege it appears that owing to the great demand for hands in the coal and iron works, farm-labourers receive more wages with board than they receive in Luxemburg without it.

The food of the working classes, not only of Belgium, but of all the countries of the Continent, consists of vegetables; meat is not the food of the working classes, either of Belgium or of any other country. It is the relish used with food. The Italian eats maccaroni; the staple food of the French and Germans is bread or cabbage; of the Irish, potatoes, (and the consumption of potatoes, as a main article of sustenance, is by no means confined to the United Kingdom, but is rapidly spreading over the Continent.) It is a beautiful fiction to describe John Bull as eating beef. If "John Bull" means two-thirds of the population, John Bull is living on vegetable diet; and not above one-third of him is nourished by meat. The

*N. B.—Shepherds are well paid, and earn 54 francs a year, their board, and thirty sheep, or 272 francs without sheep.

Indians eat rice; the West Indians, yams and bread tree; the Africans dates; in fact, a fraction, and that a very small one, of mankind are carnivorous.

The workmen employed in the iron-works of the Hainault, Liege, and the machine-making factories both of Seraing, Bruxelles, Ghent, &c., live on potatoes and vegetables, with a piece of meat among them, for dinner regularly; coffee of chiccory; and on the Sundays, spirits in moderate quantity. These are the best paid.

The workmen who come under the second class are the masons, blacksmiths, carpenters, &c. of the towns, the woollen factory and domestic weavers, who live nearly in the same manner, but consume either a less portion of meat, or take it only three or four times a-week.

The cotton weavers and factory workmen live less well. Potatoes and vegetable soup form their chief food, with bread half rye and half wheat; coffee and occasionally a glass of spirits, and commonly brown beer, are their beverage. This beer is particularly nasty, but, I believe, wholly free from coculus indicus, &c. &c.,—pure malt, hops, water, and salt, ill proportioned, and execrably boiled.

With regard to the prices of food, an able-bodied man will support himself comfortably on 7*d.* per day in Belgium, in the country. Bread, such as labourers eat, is about 1¼*d.* per lb. in the country; other food in proportion.

The price of grain was as follows, per hectolitre, or 22 gallons, equal to 2¾ bushels.

	1834.	1835.	1836.
Wheat, white,	13 fr. 19 cent.	14 fr. 3 cent.	15 fr. 56 cent.
Do. red,	14 fr. 53 cent.	15 fr. 8 cent.	
Rye, - -	8 fr. 41 cent.	9 fr. 4 cent.	10 fr. 5 cent.
Oats, - -	5 fr. 90 cent.	6 fr. 57 cent.	
Potatoes,	3 fr. 21 cent.	3 fr. 90 cent.	

The cottages of the country, peasants and artisans, are proverbially neat and clean, and so I universally found them; but my visits to the poor districts in Brussels presented a very different result. The houses where the poor live are dirty, close, crowded, and offensive.

TO BE CONTINUED.

NOTICE FROM THE FRENCH JOURNALS. TRANSLATED FOR THE JOURNAL OF THE FRANKLIN INSTITUTE, BY J. GRISCOM.

Substance of some New Researches on the Disengagement of Heat by Friction. By M. BECQUEREL.

Bodies are considered as formed by the union of an infinite number of molecules, or atoms, surrounded by heat which opposes their immediate contact, aside from all theoretical opinions of its nature. When the quantity of it increases or diminishes, the distance between the molecules becomes greater or less, and the volume of the body experiences corresponding variations.

It is admitted also that these same molecules are subjected to an attractive force which tends to bring them together, and which is consequently opposed to the repulsive influence of caloric. Finally a third force is allowed to interfere in the constitution of bodies,—the attraction of each molecule, for the heat which surrounds the neighbouring particles. When

the force of aggregation predominates over the two others, the body remains solid; if the heat increases, a period arrives at which the molecules acquire a certain mobility and the body becomes liquid. Eventually, if the quantity of heat becomes so great as to overcome the force of aggregation, the body assumes the gaseous form. The molecules of bodies being thus held at distances greater or less in proportion to the reciprocal action of heat and attraction, they must be separated by interstitial spaces in which the phenomena of light, heat, affinities and molecular attraction have been shown to operate. It is therefore in these spaces that the imponderable agents incessantly contend with the material principles of bodies.

Heat must act the principal part in this operation; for, according to its intensity and mode of action it produces light, electricity and the play of chemical affinities. It is obvious therefore that the properties of this agent cannot be too carefully studied in its relation to the particles of bodies, if we wish to arrive at a knowledge of its immediate influence in all that concerns natural phenomena of the most elevated order. These considerations have suggested the idea of a series of experimental researches which have led to some new results, which we shall endeavour to point out without going, as far as we might do, into technical details which it might be difficult to render perfectly clear in a rapid lecture.

Take a body at an equilibrium of temperature with the surrounding medium. If, by any cause whatever, this body be agitated so as to cause its molecules to lose their position of natural equilibrium, it is very evident that all the imponderable agents which existed in the intermolecular spaces will be put into motion. A multitude of phenomena would in consequence result, which the philosopher undertakes to analyze by the means which science has placed at his disposal. We shall confine ourselves at first to the effects of heat produced when friction is the mode of agitation made use of.

We know that when two bodies are rubbed against each other, heat and electricity are disengaged; are these two effects, which are concomitant, dependent, or not, upon each other? This we shall speak of hereafter. At present let us confine ourselves to the effects of heat.

All that we know of the production of heat by the mutual friction of two bodies is reduceable to this; the two bodies grow warm, and the quantity of heat emitted is sometimes so considerable as to inflame combustible substances. Thus a wheel turning rapidly on its axis takes fire, and the savage, with an address and dexterity that we are strangers to, inflames pieces of dry wood by rubbing them with great velocity against each other.

In all such cases we are led to the belief that the effect is owing to a vibratory motion of the particles produced by the friction, as the following facts tend to prove.

When an alloy, composed of one part iron and two parts antimony, is subjected to the file, bright sparks are immediately produced, showing that the temperature is increased to incandescence. The flint and steel exhibit the same effects.

Rumford, by boring a cannon placed vertically, obtained heat enough to boil water in a cavity made for the purpose of boiling it. This then is nearly all that we know about the disengagement of heat by friction. We are completely ignorant of the manner in which a body acts in the production of this phenomenon according to its own nature and the condition of its surface.

In order to determine how each substance intervenes, we must find the meansof separating all the causes which mask or conceal the effects which

we have in view. Unhappily we cannot accomplish this in a perfect manner. In fact, when we rub two bodies against each other more or less rapidly without breaking the contact between them, there is evidently a transmission of heat from one to the other. The quantity transferred from each of them depends on the conductibility of the substance, on its capacity for heat, and on the state of its surface. On the other hand, the heat disengaged in a body cannot be detected immediately before its transmission into the other body, by means of the common thermometer, inasmuch as its indications are not instantaneous. Nevertheless, it is possible to operate under circumstances which allow us to remove some of the difficulties just alluded to, and we are thus conducted to a series of facts now to be described.

The apparatus for this purpose is composed of a thermometric pile in connection with an excellent multiplier. Its sensibility is such that a difference of about $\frac{1}{100}$ of a centigrade degree, in the temperature of the two faces of the pile, causes the magnetic needle to deviate so far that the angle becomes appreciable.

To reduce the question as much as possible to its simplest expression, we take two bodies of the same nature, bad conductors of heat, equal in all their dimensions, and differing only in the condition of their surfaces. These bodies are attached to glass rods. The rubbed surfaces are placed each in contact with one of the faces of the pile; when those two surfaces are of the same temperature the magnetic needle remains at rest, since the two thermo-electric currents being equal and in contrary directions destroy each other; but when the temperatures are not the same, the needle deviates immediately and the angle of declination shows the difference of temperature. The friction is produced with a velocity and pressure determined by the aid of a particular construction in order that its intensity may be always known; the two bodies are rapidly separated from each other and experimented with immediately.

The above is the process of manipulation,—we proceed to the results.

We commence with trying the effect produced on the needle by the contact of one of the rubbed surfaces with one of the faces of the pile, an effect arising from the heating of that face.

The experiment proves that whatever be the nature of the rubbed disc, whether it be a conductor or non-conductor of heat, the time required to cause the needle to deviate to a maximum of declination, provided that does not exceed 60°, is always 10″. For deviations from 60° to 75° it is 9¼″, and from 75° to 90° it is 9″.

The needle then acts in this case like a pendulum, oscillating under the action of gravity within small amplitudes, since the deviations are isochronous; but with this difference, however, that in the pendulum, when the amplitude of oscillation increases beyond a certain limit, the time of the oscillation increases equally; whilst the contrary occurs in the experiments now described; that is to say, the time diminishes as the amplitude increases beyond 60° and as far as 92°. This result is connected with the propagation of heat and electricity in bodies.

Let us now take two bodies of the same nature, equal, and disposed as above described; for example two discs of cork, one of which has a smooth surface and the other a rough one. If we rub them against each other in a determined and regular manner, and present them simultaneously to the two faces of the thermo-electric pile, the needle immediately diverges, and the direction it takes shows that the disc with a rough surface has acquired more heat than the other, and that in proportion to the rapidity of the fric-

tion. The same holds good when we rub a piece of polished glass against another which is unpolished. We have found the former to have gained one-half less heat than the second. Hence we perceive that the absorbing power of bodies exerts an influence on the disengagement of heat in friction. This rule, however, is not general, for white satin gives more heat than black satin which has a greater absorbing power.

When bodies of different natures are experimented with, the following results are obtained: 1st. Polished glass and cork,—the first gains more heat than the second in the proportion of 34 to 5. 2d. Unpolished glass and cork; the relation of temperature is as 40 to 7. 3rd. Silver and cork,—the first is heated more than the second in proportion of 50 to 12. 4th. Caoutchouc and cork,—the temperature of the first to the second is as 29 to 11, and so of others.

From the numerous results we have obtained in the friction of bodies of different natures, we are not able yet to deduce any simple laws on account of the various causes which concur to produce the general effect. It only appears that the nature of bodies, aside from conductibility, exerts an influence which the condition of the surface does not always destroy.

We have thus far found it impossible to ascertain the true cause of this influence which depends on the nature of bodies and probably on the arrangement of their molecules; but it is important to have shown this by experiment because it furnishes us with an additional element, which the theory of heat may hereafter take into view. Now, if we enquire into the relation which exists between the production of heat and that of electricity by the natural friction of bodies, the consequences which flow from recent experiments are these,—the displacement of the parts of the rubbed surfaces always gives place to a disengagement of heat and to a disengagement of electricity, two effects which have a reciprocal dependence; this dependence is so much concealed that it is impossible yet to affirm whether one precedes the other, and *vice versa;* we can only indulge in conjectures upon it, and these would induce us to believe that the heat is derived from electricity, when the bodies are of the same nature, slow conductors of heat, and differ from each other only in the condition of their surfaces: the surface which heat the most acquires negative electricity, and that which gains the least heat, the opposite electricity. When the bodies are different, the effects become very complex, and can be interpreted only by having the results before our eyes.

New facts may allow us to extend to light the relations partially discovered between heat and electricity. Phosphorescence affords this advantage. We know that this phenomenon manifests itself wherever the particles of bodies which are slow conductors of electricity are agitated by percussion, friction, heat, light, the electric shock, and also when decomposed by chemical action. These causes are precisely those which disengage electricity; now, the phenomenon being molecular, the recomposition of the electricities disengaged around molecules must give rise to an infinite number of little sparks, the totality of which must produce a glow similar to phosphorescence;—whence we are allowed to infer that phosphorescence has an electric origin.

Of the source of the phosphorescence in the Lampyreæ and infusoria we are ignorant, and if it proceeds also from electricity the important experiments of M. Ehrenberg will probably inform us. This able physiologist has just completed a careful study of the light emitted in the dark by the infusoria and annelides which render the sea luminous in certain countries,

particularly when a light breeze agitates its surface. Having placed on the porte-object of his microscope some water containing these animalcules, he was astonished to see that the diffused light which surrounded them was no other than the union of a multitude of little sparks which were emitted from all parts of their bodies, and especially from the bodies of the annelides. These sparks, which succeeded each other with great rapidity, had so close a resemblance to those observed in electric discharges, M. Ehrenberg did not hesitate to decide on their identity. He also assured himself that the light emitted is not owing to a peculiar secretion, but rather to a spontaneous act of the animal, and that it becomes manifest whenever it is irritated by mechanical or chemical means, viz. by agitating the water, or pouring in alcohol or an acid. How analogous is this to the torpedo, which throws out its discharges only when irritated? The animalcules also, like the torpedo, renew their discharges after a certain period of repose.

From this similarity of effects, under the same circumstances, can we do any other than conclude that there must be an identity in the cause? Now, in the torpedo, no one doubts, at present, that the cause is electricity; we must, therefore, admit that it is the same thing which produces the phosphorescence of the infusoria and the annelides. It is very remarkable that luminous phenomena, or others which depend on electricity, are so much stronger as the animals are smaller; and it would seem that this profusion of electric fluid emitted solely by beings of an inferior order is destined to supply other functions in beings of a more elevated order.

Is it not allowable to infer, from these facts, as Berzelius and other philosophers have advanced, that the light disengaged in combustion, which gives rise to so great a disengagement of electricity, is also but the result of the discharge of an infinity of minute sparks, produced during the combination of combustible bodies with those which are supporters of combustion?

We perceive then that the relations which connect light, heat and electricity are acquiring, from day to day, a fresh extension, and we learn that these three agents, which preside over the molecular constitution of bodies, are derived, according to all appearances, from a single principle, of an ethereal nature, diffused throughout space and in all kinds of matter.

Annales de Chimie Mars 1839.

On the Supposed Influence which the Roughness and Polish of Surfaces exerts over the emissive power of Bodies. *By* M. Melloni.

When we subject to measurement, the heat which radiates from a metallic vessel filled with boiling water, one of whose longitudinal sides remains well polished and brilliant, and the other roughened by emery, by the graver or the file, we find the quantity of heat thrown off by the depolished surface to be always superior to that which issues from the brilliant side; the difference sometimes exceeding the proportion of two to one. It is hence inferred that the observed increase of heat is occasioned by the superficial inequalities produced on the roughened side, and consequently that asperities on the surface of bodies, tend to facilitate the emission of their internal heat. I am about to communicate to the Academy a sketch of some researches, which, as it appears to me, plainly show that this supposition is entirely erroneous, and that if the superficial layers evidently contribute to vary the quantity of heat emitted by a hot body, the condition of the surface has no part in the production of the phenomenon.

I may acknowledge that, from the beginning, notwithstanding the authority of great names, the influence of polish in the radiation of caloric, always appeared to me very doubtful. It was said that internal heat experiences the same superficial obstruction in leaving the polished surface as radiant heat does in penetrating it from without. Be it so; but why should those little shining facets, which are produced by scratching, reflect less heat internally, than the polished surface of a single piece? Take a receiver of brass, having two polished sides slightly tarnished by exposure to the air. On one of these sides make a series of parallel furrows, by the graver; the sides of these will certainly be more brilliant than the rest of the receiver, and yet the furrowed surface will emit more heat than the smooth surface. About two years ago I mentioned this objection, and that of some other analogous experiments, to Messrs. Bache, Henry and Locke, distinguished professors of philosophy from the United States of America, then at Paris. At the present time, as the question appears to me to be decided, I shall pass over indirect objections and proceed to the immediate results which lead to the proof of what I am advancing.

I took a cubical vessel of copper whose four faces were well prepared, and soldered upon the angles and edges at the bottom, small spring slides, in such a manner as to press tightly against the sides of the cube plates, two or three lines thick. Then having procured two pair of plates, one of jet and the other of ivory, I applied them to the four sides. Each pair was composed of plates perfectly equal in all respects except in the condition of the external surface, one of which was smooth and brilliant, and the other unpolished and scratched with emery. Measuring with exactness by the thermo-multiplier, the quantities of heat emitted by the two polished faces when the receiver was filled with hot water, and comparing them with that which issued from the corresponding roughened surfaces, I found a difference of only one to two hundredths, and that sometimes on one side and sometimes on the other: the mean of twenty trials gave a variation of scarcely a few thousandths, and which of course was unworthy of notice.

It may be objected that in this experiment we are not certain that the two similar plates, notwithstanding the care taken to maintain their contact with the vessel, were of equal temperatures.—To obviate this objection, I had a little block of marble formed into a cubical vessel, the sides of which were reduced to an exactly equal thickness. One of the external surfaces was left smooth and polished. The second likewise smooth, but tarnished and depolished, the third furrowed in one direction, and the fourth cross furrowed perpendicularly. The vessel when filled with hot water, threw off from the four sides equal quantities of heat.

It appears, therefore, that a more or less irregular condition of the surface has no influence on the emissive power, when the radiating body is not metallic.

I covered with lamp black, one of the faces of my marble vessel, as well as one of the plates of each pair in the previous experiment. Calling the emissive power of lamp black 100, I could easily determine by proportional numbers the emissive powers of ivory, jet and marble: all three were comprehended between 93 and 98. May it not be alleged that if in these substances the influence of depolishing amounts to nothing, it is because their emissive power was near the maximum beyond which an increase was not to be effected, the emissive surface being unable to prevent the issue of its heat; while in the metals, very far from this limit, an alteration in the con-

dition of the surface must necessarily exert all its influence, and become sensible by the great difference in the heat emitted.

Though this reasoning is founded on a pure hypothesis, namely, that lamp black opposes no resistance to surface radiation, and that the emissive power of the three substances may be, on the one hand, far enough from 100 to allow us to appreciate the variation produced, and on the other so energetic that the least proportion of a change occurring in their values would cause them to overleap the whole distance which separates them from this number; nevertheless we will abandon for a moment non-metallic substances, and try to resolve the question by the bodies themselves, with which we first set out.

Copper, zinc, pewter and tinned iron, which, as far as I know, are the only metals that have been employed thus far in experiments on this subject, when exposed to the air, are speedily coated with a slight invisible oxide, but whose presence is manifest from certain electric phenomena.—Now we know that the emissive power is much stronger in oxides than in metal. It may happen then that the scratched surface, presenting to the air a greater number of points of contact, becomes more abundantly oxidated than the polished surface, and thus has its radiating power increased by the simple fact of oxidation, independently of the greater or less regularity of its superficial points having any thing to do in the matter.

To ascertain whether this view of the case is supportable, we have only to operate with gold and platina. To this trial I had recourse; but the abraded surfaces of platina and gold gave me a calorific emission much more abundant than the polished plates of both these metals.

Oxidation, as well as the influence of polish in non-metallic bodies, being then excluded, what is the peculiar alteration in metals which may accompany, in these bodies, the change, more or less extensive, to which their outward coat or layer is subjected? This can be no other, in my opinion, than a change of hardness or density. In fact, jet, ivory and marble are substances in which compressibility is almost completely absent, or at least they do not possess in any sensible degree, the property of retaining, in a stable manner, the modifications of density and hardness which a mechanic force may chance to impress upon them. They are fashioned into plates without the aid of pressure. Metals on the contrary are compressible, and the common sheets so well known in commerce, are, as is well known, produced by the powerful pressure of the hammer or the rolling press. These sheets, as well as wire, are well known to possess greater specific gravity and hardness than cast metal. How do we know that this greater hardness and density are uniformly distributed throughout all points of the mass. Is it not more probable that during the operation of rolling, the surface undergoes a pressure and condensation greater than any other part, and that the resulting sheet is definitively enveloped with a kind of crust of superior density and hardness to the internal layers? This admitted, it is clear that in scratching the surface, we open into portions of less density or hardness. Now in glancing at the tables, which present the radiating power of bodies, we perceive that these powers follow, in general, the inverse ratio of densities. Admitting from analogy that the same law takes place in the various states of condensation of the same substance, we must infer that by making furrows in the surface of a plate we ought to obtain an increase of radiating power. Add to this, that the parts which compose the superficial coating, being disengaged by the subdivision of their mutual contact, must be loosened, and thus acquire by

a diminution of density an emissive power which approaches to that of the more tender layers within.

It follows from this view: 1st, that a polished plate of metal radiates a quantity of caloric increasing in proportion to the diminution of the density or hardness of its layers; 2d, that in cases of the least density or hardness the increase of the radiating faculty, produced by taking off the polish, will be inferior to that obtained by thus treating plates of greater density or more thoroughly encrusted.

It is almost unnecessary to add that in verifying those theoretic views we must not employ an oxidable metal at an elevated temperature, for a plate of this kind of metal has a tendency to increase its emissive power, which varies from one moment to another with the condition of its superficial coating, and the more as these coats become more tender and more divided.

Strong percussion, and a slow passage from the fluid to the solid state, are the two means by which we may vary the density of metallic bodies. I had two plates of very pure silver made by strong hammering, and two others by melting and slow cooling in their moulds of sand. With these I formed a hollow rectangular prism to which I gave a metallic bottom. They were united by soft solder so as not to alter their densities or temper during the operation. The four lateral faces were perfectly polished by pumice stone, or charcoal, without the aid of the hammer or burnisher. One of the melted and one of the forged plates were then well rubbed in one direction with paper coated with coarse emery; the images of objects which appeared very clear and distinct on the polished plates were completely effaced by the rubbing, which rendered them dull and streaked. The silver vase, thus prepared, was filled with hot water. The four lateral faces turned successively to the opening of my thermo electric instrument produced on the galvanometer the following deviations:

10° on the forged polished plate.
18° on the forged roughened plate.
13.7° on the cast polished plate.
11.3° on the cast roughened plate.

In comparing these four results, we find, 1st, that in the polished plates, the cast metal gives about a third more heat than the forged, which demonstrates the influence announced in the case of minor density; 2d, that the effect of roughening, on the two kinds of plates, differs not only in intensity, as was predicted, but in sense *(sens;)* for if the radiating power of the forged silver receives an augmentation of four-fifths by the action of emery, that of the melted silver undergoes, on the contrary, a *loss* of almost a third.

This unexpected fact, which proves in an irrefragable manner the truth of our fundamental proposition, is perfectly explicable on the theory which we had just before developed, for the pressure of a hard body like emery on the tender surface of the melted silver, compresses and condenses to some extent the rubbed particles, and renders the bottom of the furrows on one of the plates harder than the entire surface of the corresponding plates.

I regret having been unable to operate in the same manner on vessels of gold and platina, in which these manifestations, in all probability, would have been exhibited on a more extensive scale, on account of the great dif-

ference of density producible on these two metals by fusion and percussion.

In referring to the early observations of Leslie, we see that the several metallic plates that he employed gave him constantly a greater emissive power when rough and irregular than when smooth and polished. Nothing appeared more natural after this than to admit, in the phenomena of calorific emission, independent of the influence arising from the quality of the superficial layers, a special influence due to their degree of polish, at least with respect to the metals, and these were the conclusions derived from the facts observed by Leslie,—and, nevertheless, this conclusion, apparently so simple and direct in appearance, was considered inadmissible.

This example may serve, on occasion, to moderate the luckless facility with which certain experimenters hasten to put forth in the form of general laws, the consequences resulting from their early observations. It too often suffices, by taking an instrument in hand and employing it in some particular research, to fall upon a new fact; but in pursuing the labour with assiduity, in varying the method of experimenting; analyzing the phenomena under different aspects, it almost always happens that the labour ends in the perception that the novelty was only in appearance, and that the true explanation falls under the truths already classed in science; or, if a new truth finally results from the labour, it is almost always contrary to those pretended general laws which first presented themselves to our minds in a manner so attractive and decisive. Annales de Chimie et de Phys. Avril, 1839.

Notice of various New Reactions determined by Platina Sponge, and considerations of the service which this substance may render to Science. By M. Kuhlmann. *(Acad. des Sc. t. 7.)*

I have made a great number of experiments on spongy platina, the principal results of which are:

1. Ammonia mixed with air in passing at a temperature of about 300° on platina sponge, is decomposed, and the azote it contains is completely transformed into nitric acid, at the expense of the oxygen of the air.

2. Cyanogen and air, in like circumstances, give rise to the same acid and to carbonic acid.

3. Ammonia, involved in any saline compound whatever, acts as if it were in a free state.

4. In no case does pure azote combine with free oxygen; but all the compounds of azote, under the influence of platina sponge, pass to the state of nitric acid.

5. The protoxide and deutoxide of azote, hyponitric acid and nitric acid, mixed with a sufficient quantity of hydrogen, are transformed into ammonia by contact with the sponge, and more frequently without the aid of heat; the action becomes so energetic that it often occasions violent explosions. All the azote of these acids passes to the state of ammonia in uniting with hydrogen. An excess of nitric acid produces nitrate of ammonia.

6. Cyanogen and hydrogen furnish ammonia in the state of hydrocyanate.

7. The deutoxide of azote in excess, and olefiant gas, in passing in a heated state on platina sponge, produce, besides water and azote, ammonia united with hydrocyanic and carbonic acids.

8. With the deutoxide of azote and an excess of alcoholic vapour, we ob-

tain ammonia united to hydrocyanic and carbonic acids, accompanied with water, olefiant gas and a deposite of carbon.

9. Free azote does not combine with free hydrogen; but all the compounds of azote were transformed into ammonia by free hydrogen or carbonated hydrogen.

10. In these last reactions, the presence of carbon, in combination with azote or hydrogen, gives rise to hydrocyanic acid.

11. All the metalloids, gaseous or vaporisable, unite without exception with hydrogen, under the influence of spongy platina.

12. The vapours of acetic acid mixed with hydrogen are totally transformed into acetic ether (acetate of ether) and into water at a moderately elevated temperature.

A fact well worthy of remark is, that in substituting platina black for the sponge, the energy of the action is infinitely less in the greater number of cases, contrary to what might have been supposed. This action is null for the production of ammonia, and never does the platina black become incandescent as does the sponge. For the transformation of acetic acid into ether, the action of the platina black, is, on the contrary, more vigorous, and produces it at common temperatures.

These facts are sufficient to show, very evidently, the future importance reserved for divided platina. It may serve in the fabrication, at pleasure, of nitric acid or ammonia with azotized materials, and even of alcohol with vinegar, since acetic ether is, as we know, decomposable by alkalies and water, into alcohol, &c.

Annales des Mines tom. xv 2liv.

On the Oxide of Antimony. *By* M. Jules Bourson.

Berzelius, in his Traité de Chimie, tome II, page 496, and even in his new German edition, points out as the means of preparing the protoxide of antimony *(acide antimonique)* to treat the metal by nitric acid and to digest the resulting sub-salt of antimony in several successive waters until the water no longer reddens litmus paper.

The oxide, says Berzelius, then appears in the form of a white powder with rather a dirty aspect.

The characters which are known to distinguish it from the two other compounds of oxygen and antimony, are, to melt at a red heat and then to volatilize.

Having remarked that the oxide prepared by this process possessed none of these characters, I prepared a quantity with more attention, using antimony obtained by reducing the chloride by a zinc plate, thinking by this means to conduct the experiment under more favourable conditions.

I treated a portion of this metal with weak nitric acid, and another with concentrated acid, pursuing the process of Berzelius.

The two products, dried in a water bath, were assayed, comparatively, with oxide prepared by decomposing the chloride by water and washing the precipitate with carbonate of potash. The latter heated on a brick by the blow pipe, promptly melted and immediately volatilized; while the two others neither melted nor volatilized; and in subjecting both to the action of heat in a porcelain retort, they both gave out a great quantity of oxygen without the least trace of nitrous vapour.

By exposing them to a degree of heat just inferior to that which would decompose them, they gave out water, and yielded a product of a fine citron yellow.

These characteristics evidently prove that the process indicated by Berzelius, far from furnishing the oxide of antimony, yields, on the contrary, antimonic acid, and I may add, that by employing antimony divided in the way I have mentioned, and which, by the way, is obtained with great facility, we have an excellent process for preparing that acid.

It is presumable that Berzelius used in this preparation, antimony that could not have been sufficiently pulverized; that the interior parts of the metal could not have been attacked by the nitric acid, and that the product was only a mixture of metallic antimony and antimonic acid; the dirty white colour assigned above to the oxide, supports what I have advanced, and the following experiment tends to confirm it.

I made a mixture of antimony in powder, and of oxide obtained from the reduced metal, and heated it with the blow pipe,—the fusion which began to be observable was due only to the presence of the metal, which by the contact of air was oxidized, and then volatilized. I also treated pulverized antimony in the cold with nitric acid, and the product washed and dried, comported precisely like those which had been prepared with the reduced metal. By exposure to heat, it emitted only a small quantity of nitrous vapour, but there was no indication of fusion or volatilization.

Annales de Chimie, Jan. 1839.

On a New Process for Determining the Carbon in Cast Iron and Steel.

By M. V. Regnault, *Mining Engineer.*

This operation is very easy and may be executed with great exactness by the following process.

Take 5 grammes (= 75 or 80 grains) of cast iron, reduced to filings while the iron is soft, or pulverized in a mortar while most brittle,—mix it with 60 or 80 grammes (= 930 or 1240 grains) of chromate of lead previously melted. Set aside a third or fourth part of this mixture;—add to the remainder 75 grains of chlorate of potash, which contains about the requisite quantity of oxygen to change the iron to a peroxide;—then introduce the triple mixture into a glass tube similar to those used in organic analyses, but not necessarily so long. Next put over this the mixture of iron and chromate of lead which had been reserved;—adapt the tube to the common apparatus of Liebig for organic analysis.

Heat that part of the tube which contains the mixture without chlorate, and when red hot, begin to heat the part containing the chlorate, and advance the heat as the disengagement of gas slackens. In this way the cast iron burns at once almost completely by the oxygen of the chlorate, and a very small portion only of this gas escapes from the tube. The temperature afterwards becoming more elevated, the combustion is completed by the chromate of lead, which, in melting, oxidizes the last portions of the iron.

It is proper to enclose the tube in a wrapper of copper, because towards the conclusion it must be heated so thoroughly as to produce the perfect fusion of the chromate.

The oxidation of the iron is complete, as may be proved by rubbing up the contents of the tube after combustion;—not a particle will be found attractable by the magnet. The analysis is so easily accomplished that it may be finished in less than half an hour.

We may judge of the perfect agreement of the results by the three following analyses, made on the same gray iron obtained by hot air.

I. 5 grammes gave 0.582 carbonic acid.
II. 5 do. do. 0.585 do.
III. 5 do. do. 0.588 do.

	I.	II.	III.
Carbon,	3.22	3.23	3.25

When the iron contains sulphur, not a trace of sulphurous acid is disengaged; the sulphur remains wholly in the tube in the state of sulphate of lead. I have assured myself of this by treating sulphuret of iron by this process.

With chromate of lead alone we do not obtain all the carbon; the chromate, by losing oxygen, becomes less fusible, and the oxidation penetrates with difficulty to the centre of the larger grains of iron. Ibid.

On the Preparation of Potassium and Sodium. *By* M. Werner. *(Journ. fur. prat. Ch.)*

It is extremely important for the successful preparation of these metals, to use an exact proportion of charcoal and alkaline carbonate. For the common quicksilver bottles there should be twenty ounces of cream of tartar, calcined in a close vessel and reduced to fine powder, to which add twenty drachms of charcoal also in powder, and twenty-four drachms of broken charcoal of the size of beans. Moisten the whole with a little water, and when the bottle containing the mixture has been placed horizontally in the furnace, push down the mass with an iron rod, so as to leave the neck perfectly free.

The neck of the bottle should not issue more than three inches beyond the furnace, and it must not be cooled that the metal may not condense in it. This cooling may be avoided by attaching to the neck a stopper of gypsum an inch long. Notwithstanding this precaution, the tube becomes obstructed three or four times in the course of the operation, but it is easily cleared by the iron rod.

The retort should be heated very slowly so that it may take an hour for the green vapours of the volatile metal to begin to shew themselves: then the receiver is to be attached, and a very uniform temperature to be kept up during the operation which commonly lasts three or four hours. From three and a half to four ounces of potassium, in large, pure lumps are produced, with carburet of potassium mixed with a little charcoal.

In the preparation of Sodium we must take a pound and a quarter of acetate of soda, carbonized *(charbonné)* mixed with a sufficient quantity of charcoal; and from this we get three and a half, four, and even four and a half, ounces of metal.

It is essential that the bottle be well luted with sand and clay, and the luting should be wrapped with a netting of iron wire. With these precautions the bottle may serve for two operations, care being taken to renew the lute.

Annales des Mines tom xv.

On the Carbonization of Vegetables. *By* M. Cagniard de la Tour.

In heating, over the naked fire, closed glass tubes, into which I had previously introduced some poplar wood, either in pieces or in saw-dust, I remarked that at the moment when the wood arrived at the temperature of carbonization, namely, at about 360° C., it became flowing like bitumen,

although the wood had previously been dried ten or twelve hours in a stove heated to 100° C. From the report with which the tubes exploded at the moment when the fusion above mentioned takes place, there is reason to believe that the internal pressure, at that junction, exceeds eighty atmospheres. It is further remarkable that these tubes when they are broken after becoming entirely cold, in order to abstract the carbonized matter, which is then solid, still produce a strong explosion by the sudden expansion of the gases compressed within them.

The carbonized matter, when examined by a powerful lens, exhibits no trace of the woody texture. Heated to redness in the air, it inflames and leaves a charcoal but slightly combustible. Rubbed with alcohol it colours the liquid yellow. Ibid.

New Chloride of Chrome. By M. H. Rose. *(L'Institut*, 1839.*)*

This modification of chromic chloride, insoluble in water, and of the greatest beauty, is obtained by heating strongly a mixture of the oxide of chrome and charcoal in a current of chlorine. There sublimes immediately a body of a scaly or crystaline, lamellar texture, of great splendour and of a magnificent colour.

This form of chloride of chrome, undergoes no change by exposure to air. Sulphuric acid does not decompose it; it may be heated when covered with this acid diluted, without change; the dilute acid may be evaporated, and the concentrated acid may be vaporized and distilled without decomposing the chloride. By heating it in the air it is transformed, like the other forms, into the oxide of chrome, with a disengagement of chlorine. Ibid.

Preparing Sulphate of Iron so as to preserve it at a minimum of Oxidation. By M. Berthemot. *(I. de Phar.)*

Having dissolved and crystalized in water, sharpened with sulphuric acid, a portion of common sulphate of iron, exempt from copper and zinc, take 500 parts of it and dissolve it in 550 parts of distilled water: then add to the solution 8 parts of pure iron turnings, and after a few minutes filter it boiling hot, taking care to moisten the filter previously, that the liquid may flow through it more rapidly. Put the solution in a vessel containing 375 parts of alcohol at 33° to 36°, and 8 parts of sulphuric acid stirring it briskly with a glass rod as it is poured in. The sulphate of iron immediately precipitates in the form of a bluish white crystaline powder, and thus prepared it will remain in the air without the least alteration. It contains, besides, the same proportion of water of crytallization as that which is deposited from an aqueous solution. It is only after boiling it for some time in strong alcohol that it gives up a portion. Ibid.

Presence of Arsenic in Tin. By M. Wöhler. *(Ann. de Phar. t.* 29.*)*

The greater number of the tins of commerce contain arsenic. I have found none, except the tin of Banca, and an English tin in lumps,* which are exempt from it. The method of Marsh is perfectly adapted to show its presence. Dissolve from one half to one drachm of tin in concentrated

* Most probably *Stream* tin.—Trans.

hydrochloric acid, with heat, in a small gas bottle. Hydrogen gas escapes, which will not inflame immediately on account of the vapour of water and acid with which it is mixed. Collect it in a tube filled with water, and furnished with a stop cock, or otherwise connected with a pointed tube.

Inflame the gas, and let the burning jet play against a piece of cold porcelain,—the arsenic, if any be present, will be deposited, as is well known, in the form of a black shining coating. Ibid.

Action of Ammoniacal Salts on Glass. By M. MARCHAND. *(Ann. de Pog. t.* 42.*)*

Mixtures of hydrochlorate and nitrate of ammonia attack glass very strongly, especially when it contains lead.

When sulphate of ammonia is heated in a glass vessel, it begins to melt at 140°, and from that to 280° it undergoes no alteration; but at this temperature ammonia is disengaged, sulphate and sulphite of ammonia sublime, and we soon remark that the glass is strongly attacked; the interior surface becomes dull, from a combination of sulphuric acid with the potash. The glass often cracks and sulphate of potash issues through the crevices. Ibid.

Hydrographic Paper.

Paper is sold in Europe under the above title, on which, if one writes with water instead of ink, or even with the saliva of the mouth, the letters are black and perfectly legible.

This paper is prepared by steeping common white paper in a weak solution or infusion of gall nuts, and when dry rubbing over it finely powdered copperas (sulphate of iron.) It thus contains the elements necessary for the production of ink, and needs only the water necessary for their solution. The water traced by the pen effects this union and forms a black letter.

Method of Discovering the Adulteration of Wax.

The wax of commerce is too often mixed with various substances, and especially with potatoe flour. A simple method of detecting this sophistication is to melt a piece of the wax over a gentle fire, and then to dissolve it in a certain quantity of spirits of turpentine. The wax will entirely dissolve and the impurities be left behind, and by knowing the weight of the wax and ascertaining that of the sediment, the amount of the adulteration can easily be ascertained.

The colour given to wax does not, in general, injure its quality, but merely gratifies the eye of the purchaser.

Deposition of Moisture on Metals. By M. BONSDORF.

If we place, in an atmosphere saturated with humidity, a piece of polished zinc and a piece of tarnished lead in contact, when the temperature lowers the lead becomes covered with dew, and the zinc remains dry without oxydizing. It is thus with two different metals. The moisture settles on one only. If the effect be attributed to electricity we must conclude that the droplets are electrified positively. Ibid.

Progress of Civil Engineering.

Notes on the Philadelphia and Columbia Rail Road. By W. H. Wilson, C. E.

The statistical information furnished by the following article, must prove acceptable, not only to every person who travels the road in question, now the great thoroughfare through the State of Pennsylvania, but to all who take a lively interest in the progress and nature of those great internal improvements whose commencement and rapid march will forever signalize the age in which we live.

We have been surprised, in traveling over the line of Canals and Rail Roads from Pittsburgh to Philadelphia, marked as it is at almost every stage by some of the grandest features of nature, and by the triumph of art over great natural obstacles, that no description of the route has been offered to the public, accompanied with a good map. Were a pamphlet, containing a descriptive and statistical account of the road, including a map, perpared by some one of the Engineers, and kept for sale in the passenger cars, and at the different Hotels on the route, as well as at other places, we could almost vouch for the ample reward which would accrue to the author, or publisher. The same may be said of the Reading, Baltimore, and other Rail Roads. We are surprised, that no publisher by profession, has taken up this subject, and engaged some one of the Engineers, on each of our great rail road and canal thoroughfares, to prepare suitable guide books, a procedure which we find has been effected in England, and doubtless with profit, in relation to the great rail road tracks. G.

West Haverford, Del. Co., Penn.
September 12th, 1839.

From the American Railroad Journal.

Having been employed on the Columbia and Philadelphia railway during its construction, a great many notes relative to the character and cost of the different portions of the work, accumulated in my possession. Taking advantage of some leisure time this summer, (the first that has occurred since the completion of that work,) I have arranged these notes for my own satisfaction, and have added some statements relative to the subsequent operations upon the road. The object being merely to give a correct statistical account, I have abstained from giving expression to any opinions or speculations as to the character or merits of the work. In making comparisons of the performances on different railways, I have often felt the want of correct information as to the important features of the roads in question.

Under the impression that the same might be the case with others, I have thought the annexed account might not be uninteresting to your readers. Should you agree in this opinion it is at your service for publication.

Respectfully yours,

W. H. Wilson.

Columbia and Philadelphia Rail Road.

This railway commences at the corner of Broad and Vine streets, in the City of Philadelphia, and terminates at the borough of Columbia on the Susquehanna river, the length being $81\frac{6}{10}$ miles. It has been constructed and is still owned by the State of Pennsylvania.

In the year 1827, surveys of the route were made by direction of the

Legislature, and on the 24th of March, 1828, the construction of the railway was authorised as a State work. The location was commenced immediately after, and early in the year 1829 the grading and bridging of 40 miles of the road were put under contract; different portions of the work were successively contracted for, according to the yearly appropriations made for that purpose. On the 20th September, 1832, twenty miles of single track were opened for traveling; in April 1834, a single track was completed throughout, and in October of the same year, both tracks for the entire length of the road were open for public use. Much incidental work was, however, done after that time, the buildings for depots, workshops, &c. being in an unfinished state and some turn-outs, farm bridges, &c. not constructed.

Major John Wilson had charge of the operations on this line as Chief Engineer, from the commencement of the preliminary surveys, until a short time previous to his death in the spring of 1833, after which time the work was placed under the direction of Edward F. Gay, Esq. The following description will afford some general idea of the prominent features of this railway. From Broad street the line takes a northwesterly course passing near the Fairmount water works, and from thence runs nearly parallel to the Schuylkill river, which it crosses at the distance of about three miles from the city, the grades being undulating, to conform to the inclinations of the streets which are crossed. Immediately west of the river is an inclined plane of 2805 feet in length and 187 feet in height; this plane is straight and its inclination uniform. From the head of the inclined plane, the line is continued on the dividing ridge between waters flowing into the Delaware and Schuylkill, for about 19 miles, to a point near the intersection of the West Chester railway, where it attains an elevation of 543 feet above high tide; the grades on this portion of the road are varied and undulating, but generally ascending westward. The road now descends the northern slope of the South Valley hill into the Great Chester Valley, and after crossing Valley creek, comes to the East or Big Brandywine, at Downingtown; for nearly the whole distance, (about 11 miles,) the descent is at the rate of 29 feet per mile. The height of railway above high tide at Brandywine bridge is 250 feet. From East to West Brandywine, a distance of about 7 miles, the grades are generally ascending, the whole rise between those points being 121 feet. After crossing the West, or Little, Brandywine near Coatesville, the line ascends the Southern slope of the North Valley hill, until it reaches the summit of the Mine ridge at the Gap. According to the first location, an excavation of 37 feet was required at this point, but upon removing a few feet of the surface, the material below was found to be quicksand; after losing a great deal of time, and incurring heavy expense, in efforts to work down this cutting, it was deemed advisable to raise the grade so as to reduce the depth of excavation to 23 feet; in consequence of which, the grade now stands at 45 feet per mile, descending each way from the summit for three fourths of a mile, and then at forty feet per mile, for one-fourth of a mile, when it meets the original inclination of thirty feet per mile. The Gap summit is 553 feet above high tide at Philadelphia. From this point the road descends, and after crossing Pequea creek, Mill creek, and Big Conestoga, enters the city of Lancaster; leaving which, it is conducted across Little Conestoga, towards the head of the inclined plane at Columbia. This plane is 1800 feet in length and 90 feet in height; it is straight and its inclination uniform. From the foot of the plane, the road continues along the margin of the river

Susquehanna, in front of the town, to the outlet lock and basin of the Pennsylvania Canal. It is graded along the edge of the basin, sufficiently low for the convenient transfer of articles from one mode of conveyance to the other.

The passage of a law to authorize the construction of this railway by the Commonwealth, met with serious opposition, and even after the work had been commenced, it was for some time a matter of doubt whether operations would not be suspended. Under these circumstances, it was the earnest desire of the friends of the road, that as much economy should be used in the construction, as was consistent with a due regard to the utility of the work, when completed. Previous to commencing the location, it became necessary for the Engineer to determine upon its governing principles, and in order to establish these, recourse was had to the experience gained upon works of a similar kind already in operation. It must be recollected that this was in the year 1828, previous to the opening of the Liverpool and Manchester railway, when there were but few railways of any extent in use, and those of very imperfect construction. It was also prior to the successful use of the locomotive engines; it is true that these machines were then operating upon some of the English railroads, but their use was attended with so many objections, that very few were sanguine enough to anticipate their general adoption. After the most mature consideration of the subject, the maximum grade of the Columbia and Philadelphia railroad, was fixed at 30 feet per mile, and its minimum radius of curvature, at 631 feet, these being the limits to which it was thought prudent to go, with an eye to economy of construction on one hand, and the useful effect of the road on the other. The principles here laid down have been adhered to with one exception, which is the increase of grade in surmounting the Mine ridge at the Gap; the distance however for which the grade has been raised is so short, that the difference is scarcely felt by trains passing over the road. It may be proper to observe here, that in references made to this railway by companies prosecuting rival works, or by others interested in representing it in the most unfavourable light, the minimum radius of curvature is stated at 300 feet; there is a curve of this radius 7 chains in length, at the termination of the road, but it is in the streets of Philadelphia, beyond the point at which the locomotive engines are stopped and the trains separated, and ought no more to be taken into view, when referring to the road, than ought the numerous abrupt curves through the Northern Liberties, to be considered as parts of the Trenton Railway. The inclined planes on this road being a source of expense and delay to the transportation, every possible effort has been made to avoid them. A new route of six miles in length has been located, and is now nearly completed, by which the plane at Columbia will be dispensed with; the distance is about the same as the part of the old line to be abandoned, and the grade 35 feet per mile. Several routes have been surveyed for the purpose of avoiding the inclined plane near Philadelphia, but as yet no alteration has been adopted by the State. Two roads have been commenced by chartered companies for this purpose. The West Philadelphia railway is about 8 miles in length, its maximum grade 57 feet per mile, and its average grade $43\frac{3}{10}$ feet per mile; the grading of this road is principally done, but the work is now suspended for want of funds. The other route is by the Valley and Norristown railroads; the distance by the Valley road is $20\frac{1}{4}$ miles, and then by the Norristown road $13\frac{1}{2}$ miles, making a total of $33\frac{3}{4}$ miles or $2\frac{1}{8}$ miles more than the portion of the State road to be avoided; the maximum grade of the

Valley road is $35\frac{7}{10}$ feet per mile, and of the Norristown $37\frac{4}{10}$ feet per mile; the latter road is graded for two tracks, and has one track now in use; on the Valley road the grading is partly done. On no other route yet surveyed for avoiding this plane is the grade less than 40 feet per mile.

The following is a summary of the straight lines and curves on the Columbia and Philadelphia railway.

	Miles.	Chains.	Links.
Straight line,	56	62	54
Curve of 3782 feet radius,		75	25
" 1981 "	5	24	16
" 1513 "		57	00
" 1260 "	6	16	73
" 968 "		8	42
" 946 "	6	29	04
" 841 "		0	67
" 757 "	3	61	29
" 631 "	1	25	95

Grading.—The width of road is 25 feet in the excavations, and by the original design it varied on the embankments from 22 to 25 feet according to the supply of material, but at this time the top width of embankments generally exceeds 25 feet. The deepest cuttings on the line are between 30 and 40 feet, and the highest embankment is 80 feet.

Inclined planes.—The inclined plane at Schuylkill river is 2805 feet in length and 187 feet in height; at the head of the plane is a building composed of two wings built of stone, connected by a wooden structure over the roadway. Each wing is calculated to hold a stationary steam engine of 60 horse power; only one, however, has been put up. The rope is an endless one, of nine inches circumference when new, and cost about $2,800. The first rope used was $6\frac{3}{4}$ inches in circumference, cost $2,100, weighed $5\frac{1}{4}$ tons, and lasted about one year. The inclined plane at Columbia is 1800 feet in length, and 90 feet in height. The engine house at the head of plane is built of brick, and designed to accommodate two steam engines of 40 horse power each, one of which is put up. On both of these planes double tracks are laid, and cars are passed up and down at the same time.

Culverts.—The culverts are all built of stone, and the masonry is either hammer dressed, or rubble work; they are 75 in number, with spans varying from 4 to 25 feet, and contain 31,161 perches of masonry.

Bridges.—The number of railway bridges, or viaducts, is 22; they are constructed with stone abutments and piers, surmounted by wooden structures, and contain 61,425 perches of masonry, and 7,212 lineal feet of wooden platform. Two of these bridges, supported on small stone piers and wooden trestles, have lately been replaced by embankments. There are 33 bridges across the railway for public and private roads. The following are the most important viaducts.

Schuylkill viaduct.—The superstructure is composed of wood, with four distinct trusses, formed of arch pieces, king posts, and braces, being a modification of Burr's plan. The whole width from out to out, is 49 feet 8 inches, which admits of three separate passages, two of $18\frac{1}{2}$ feet each, in the clear, and one of four feet; the latter is intended for foot passengers, one of the former for two railway tracks, and the other for common carriages. The spans are seven in number, and their lengths in clear, between the piers are as follows; two of 122 feet each, three of 135 feet each, and two of

137 feet each. The eastern abutment and four piers are founded upon solid rock; the remaining abutment and piers, upon hard gravel. The masonry is coursed and hammer dressed. Five of the piers were built in the river and required coffer dams; one of which stood in 26 feet depth of water. The whole length of wooden platform is 1,045 feet, and the number of perches of masonry 19,100. The height of the bridge floor above the usual water line, is 38 feet. The total cost including painting inside and outside, was $133,946.57.

Valley Creek viaduct consists of four spans, each 130 feet in clear between the piers. The piers are built of rubble masonry, and vary from 56 to 59 feet in height. The original structure was on Burr's plan, having two trusses, with a clear width of 18½ feet, and cost, including stone work, $22,254.21. The wood work was destroyed recently by fire, and replaced by a lattice bridge (lowered so as to admit of the railway being carried over the top,) at a cost of $17,218.13.

East Brandywine viaduct has four spans, two of 88 feet 8 inches each, and two of 121 feet 7 inches in the clear. The superstructure is on Burr's plan with a clear width of 18½ feet. The whole length of platform is 477 feet, and the height of floor above water in the creek, 30 feet. Cost $17,523.20.

West Brandywine viaduct has a wooden superstructure, resting upon abutments and piers of coursed masonry with rustic faces, commonly denominated rock work. The length of the bridge platform is 835 feet divided into six spans; its greatest height above the water is 72 feet. The whole cost of stone and wood work is $57,916.00. The plan is similar to that of the bridge over East Brandywine, except that the superstructure is lowered for the railway to pass over its top. This and the new bridge at Valley Creek, are the only two of the principal structures, on this line, in which the usual form of roof is dispensed with.

Pequea viaduct is a single span of 130 feet, on Burr's plan, and cost $8,735.50.

Mill Creek viaduct is built on Burr's plan; the whole length of wooden platform is 550 feet, and its greatest elevation from the water 40 feet. Cost $9,273.18.

Big Conestoga viaduct is 1,412 feet in length, and is elevated 60 feet above the water. The piers are built of rubble masonry, and the superstructure is lattice work on Town's plan. Whole cost $31,503.57. The longest span of this bridge is 120 feet.

Little Conestoga viaduct.—The piers are built of rubble masonry and the wood work on Burr's plan. The flooring is 804 feet in length, and is elevated 47 feet above the water of the creek. Cost $15,359.00.

Railway superstructure.—The length of road being, as before stated, $81\frac{6}{10}$ miles, there are $163\frac{2}{10}$ miles of single track; of which six miles are laid with granite sills plated with flat iron bars, 18 miles with wooden string pieces plated in a similar manner, two miles with stone blocks and edge rails, having stone sills extending across the track at every 15 feet, and $137\frac{2}{10}$ miles with stone block and edge rails, (having wooden sills extending across the track at intervals,) except on some of the embankments, where the edge rail is secured, to cross sills of wood, supported by mud sills.

Granite Track.—The trenches are dug in the direction of the road, two feet in width, and 22 inches in depth, measuring from the level of top of sill. Broken stone is then placed and compacted in layers of 3 inches each.

Upon this are laid granite sills varying in length from 3 to 12 feet, and one foot in depth and width. Holes are drilled into the stone (to correspond with the holes in the bars, and to suit the width and position of the track) three and a half inches in depth, and $\frac{5}{8}$ of an inch in diameter. Into these holes, plugs of locust wood are driven, to receive the spikes which secure the iron bars, which are 15 feet in length, $2\frac{1}{4}$ inches in width, and $\frac{5}{8}$ of an inch in thickness. The inner edge of the sills, is chamfered off for a width of two inches, and the outside is backed up with broken stone. Horse power being used on the road when this track was laid, a horse path was formed of broken stone or gravel 6 inches in depth. The average cost for one mile of this track, including the trimming and dressing off half the width of roadway was $10,179.20.

Wooden Track.—The trenches are dug across the road, four feet apart, eight feet in length, one foot in width, and 16 inches in depth (making 24 inches to top of wooden rail.) Into these, broken stone is rammed in layers, upon which are laid sills of chestnut or white oak, seven and a half feet long and seven inches square. The sills are notched to receive a yellow pine string piece 6 inches square, which is secured in its place by wooden wedges. Flat iron bars are then spiked on similar to those used on the granite track; the horse path is also similar. This track cost $5,604.48 per mile.

The two kinds of superstructure just described, have been in use on this road about seven years, but during the last year, they have been traveled over only by a few cars drawn by horses, being so much out of order as to be unsafe for locomotive engines. The wooden sills and string pieces have become decayed, and in both cases the iron bars are constantly working loose. In many places these bars have been broken, or split, by the heavy weights passing over them, particularly on the stone track. It is intended to renew this portion of the road with edge rails; a short distance has already been done.

Edge rails on stone blocks and sills.—The trenches are dug in the direction of the road, 28 inches wide, and 24 inches deep, (from top of block;) at every 15 feet these are connected by a cross trench 16 inches wide. Broken stone to the depth of 12 inches, is well rammed in layers; the blocks and sills are then settled in their places by heavy rammers, and backed up to their tops with broken stone. The blocks are of granite, or other hard stone, 20 inches long, 16 inches wide, and 12 inches deep; the sills are of the same material, six and a half feet in length, and one foot square, placed across the track at every 15 feet; the blocks are so arranged as to give a support to the rails at every three feet. Cast iron chairs weighing 15 lbs., are secured to the blocks and sills, by bolts driven into cedar plugs previously inserted into the stone; there are two bolts to a chair, weighing 10 ounces each; between the stone and chair, a piece of tarred canvass is inserted. The rails are of rolled iron, 15 feet long, three and a half inches deep, parallel at top and bottom, and weigh $41\frac{1}{4}$ lbs. per lineal yard. The rail is secured in the chair by two wrought iron wedges, one on each side, weighing 10 oz. The horse path for this track is formed of broken stone and gravel nine inches deep. Average cost of one mile $12,568.85.

Several miles of track were laid in a similar manner to the above, omitting the stone sill, and substituting in its place two blocks, at a cost of $10,927.88 per mile. This kind of track was found so liable to spread, particularly in the spring of the year, when the ground was soft, that wooden sills have since been put in at intervals, connecting the two rails of the track.

Edge rails on stone blocks and locust sills.—This kind of track is similar to the edge rail track already described, with the following exceptions; instead of stone sills, locust are used, placed 15 feet apart on the straight lines, and nine feet apart on the curves; to suit which, some bars were rolled in lengths of 18 feet; the stone horse path is dispensed with, the tops of the blocks and sills being level with the graded surface of road. The average cost of one mile on this plan is $13,240.92; the excess over the cost of the track where stone sills were used, is owing to a rise in the cost of iron, from $41 to $50 per ton (delivered in Philadelphia.) On newly formed embankments the following plan was adopted; longitudinal trenches were dug, 22 inches wide, and 22 inches deep; broken stone to the depth of 6 inches, being rammed in, string pieces of white oak or chesnut were laid, 12 inches deep by 10 inches wide; these being notched to the depth of 2 inches, cross sills of the same material, 6 by 8 inches, were secured to them at every 3 feet by pins or wedges. On these sills the iron chairs, rails, etc., were placed. The trenches were connected at intervals, by cross trenches, running out to the edge of the embankment, for the purpose of carrying off any water which might collect. This description of track cost $12,905.35 per mile.

This road having been designed and constructed with a view to the use of horse power, a system of turn-outs and side tracks was adopted with particular reference to that kind of traveling. Turn-outs were placed at intervals from one track to the other, and side tracks were constructed, adjacent to each of the main tracks, at the distance of one mile and a half apart, for the whole length of the road; these side tracks measured as follows; 160 feet in length parallel to the main track, and 70 feet at each end, curved to the intersection with outside rail of main track. They afforded a space of about 200 feet in length for cars, and as the cars always entered in the same direction after both tracks were completed, only one movable switch was used. The castings were according to J. Elgar's plan, and were made under his direction. Upon the introduction of steam power upon the road, the numerous castings were found very objectionable, and useless; nearly all of them were consequently taken up, and most of the side tracks were also removed. Wherever it has since been found necessary for the accommodation of business to have turn-outs or crossings, new castings have been made use of, better adapted to the present mode of traveling.

The branches connected with this railway which have been completed for use are, the West Chester railway 10 miles in length, intersecting about 22 miles from Philadelphia, and the Harrisburg railway 40 miles in length, connecting at Lancaster, 12 miles from the western extremity. On the former of these roads, horse power is used; on the latter, steam power;—both belong to chartered companies. The following table exhibits the cost of the Columbia and Philadelphia railway as nearly as can be ascertained. From the commencement of the work to the time of its being opened for public use, the gross amount of the appropriations for purposes of construction could easily be obtained; but since that period various sums have been appropriated yearly to this road, some of which properly belong to the item of construction, while others have been applied to objects not connected therewith.

All the documents relating to this subject have been carefully examined and the result is believed to be as correct as can possibly be obtained.

Total cost of Columbia and Philadelphia Railway.

Grading,	$649,158 69
Culverts,	74,113 94
Railway bridges or viaducts,	327,695 80
Road and farm bridges,	42,055 00
Fencing,	65,410 86
Railway superstructure,	2,181,156 25
Buildings and machinery,	111,787 12
Engineering and superintendence,	133,934 31
Damages,	54,833 29
Repairs,	42,451 76
Incidental,	11,980 18
Alteration to accommodate the city of Lancaster,	60,000 00
	$3,754,577 20
Cost when the road was open for use in 1834; after which the following additional expenditures were made.	
Locomotive engines,	327,203 41
Additional buildings, turn-outs, &c.,	37,511 16
Retained per centage on old contracts,	5,134 08
Engineering,	4,741 25
New ropes at inclined planes,	11,584 34
Embankment at Maul's bridge,	1,796 34
Renewal of wooden track,	18,907 48
Rebuilding Valley creek bridge,	17,218 13
New road to avoid Columbia inclined plane,	118,123 53
	$4,296,796 92

The following particulars in relation to the working of the Columbia and Philadelphia railway, are compiled from the annual reports of the officers of the road, up to October 31st, 1838, the date of the last report.

	Road expenses.	Motive power expenses.	Road tolls.	Motive power tolls.	Total expenses.	Total tolls.
	$ cts.	$ cts.	$ cts.	$ cts.	$ cts.	$ cts.
From commencement of travel, to Oct. 31, '35.	41,973 13	55,246 27	185,560 67	43,790 55	97,219 40	229,351 22
From Oct. 31, 1835 to do. '36.	75,311 32	184,878 84	173,837 12	90,969 12	260,190 16	264,806 24
From Oct. 31, 1836 to do. '37.	59,024 95	114,859 76	211,324 16	137,338 67	173,884 71	348,662 83
From Oct. 31, 1837 to do. '38.	44,033 23	133,820 90	233,588 75	164,052 74	177,854 13	397,641 49
	220,343 63	488,805 77	804,310 70	436,151 08	709,148 40	1240,461 78

All the cars used on this road belong to individuals or companies, but the motive power is furnished by the State, except in the case of the West Chester cars and some few others, which are drawn by horses. Every thing connected with the management of the motive power is entrusted to an officer styled "Superintendent of motive power;" the repairs of the road are attended to by a Supervisor; these officers are independent of each

other, appoint all persons employed under them, and report annually to the Board of Canal Commissioners on the state of their respective departments. There are five offices for the collection of tolls, the incumbents of which are appointed by the Board of Canal Commissioners. Separate accounts are kept by the collectors, of the tolls received for the use of the road, and for motive power; the latter constitute a fund, out of which all expenses in that department are paid; for the repairs of the road, yearly appropriations are made by the Legislature.

The rates of toll for the use of the road vary from six mills to four cents per ton (of 2000 pounds) per mile; there are 12 different rates, the average of which would be two cents per ton per mile. The lowest rates are for coal, stone, iron ore, vegetables, lime, manure and timber; and the highest are for dry goods, drugs, medicines, steel and furs. On the United States Mail, the toll is one mill per mile, for every ten pounds; on every passenger one cent per mile. In addition to these rates, a toll is levied, of one cent per mile on each burthen car, two cents per mile on each baggage car, and on every passenger car one cent per mile for each pair of wheels. The motive power toll is, for each car having four wheels, one cent per mile, for each additional pair of wheels five mills, for each passenger, one cent per mile, and for all other kinds of loading, 12 mills per ton (of 2000 pounds.) The owners of cars now charge $3,25 for every passenger, and $7,50 for every ton of merchandize conveyed the whole length of the road, they paying all tolls: which is at the rate of four cents per mile for a passenger, and $9\frac{14}{100}$ cents per mile for a ton of goods. Taking the length of the road at 82 miles, the average number of passengers to an eight-wheel car at 30, and the load of a four wheel burthen car at three tons, we have the following results:

Road toll on an eight-wheel car,	-	4	cents per mile.
" " 30 passengers,	-	30	" "
Motive power toll on car,	-	2	" "
" " 30 passengers,	-	30	" "
Total toll for 30 passengers,	-	66	" "

or $2\frac{2}{10}$ cents per mile for each passenger, leaving $1\frac{8}{10}$ cents per mile to the the owners of the car for every passenger.

Road toll on a four wheel burthen car,	-	1	cent per mile.
" " three tons of dry goods,	-	12	" "
Motive power toll on car,	-	1	" "
" " three tons of goods,	-	$3\frac{6}{10}$	" "
Total toll on three tons of dry goods,		$17\frac{6}{10}$	" "

or 5 86-100 cents per ton per mile, leaving 3 28-100 cents per ton per mile to the owner of the car.

In making comparisons between the working of this and other railways, the error has generally been committed, of taking the motive power expenses (given in the reports of the State officers) as the whole cost of transportion; it must be recollected, that the State merely furnishes the moving power; the owners of cars have to provide their own workshops, and depots for receiving and depositing good; they are also obliged to send agents with their cars and have to take the risk of all accidents. The duty of the State agents who accompany each train, is to regulate the motions

of the train, and to see that proper returns are made to the collectors, of the passengers and freight conveyed.

Details of Motive Power expenses for the year ending October 31st, 1838.

Expended at workshops,	$14,102 05
" " inclined planes,	16,942 90
Superintendent, clerk, and car agents,	8,022 00
Car inspectors,	1,196 00
Conductor of State cars,	407 50
Engineers of locomotives,	10,786 00
Firemen,	6,662 87½
Watermen,	6,825 00
Woodmen,	8,212 22
Wood,	27,889 33¾
Coal,	10,732 67½
Materials for engines,	20,720 91½
Oil,	6,568 85
Miscellaneous,	852 62
	$139,920 94
Add amount of debts contracted,	5,600 00
	145,520 94
Deduct stock on hand, fuel, iron, oil, &c.,	11,700 00
	$133,820 84

During the same year, the number of passengers conveyed, was 103,336 way and through, equal to 75,612 through; the number of tons of freight transported was 87,180, and the whole number of miles traveled was 260,400.

List of persons employed in Motive Power Department.

Superintendent of motive power, at	$4 00 per day.
Clerk,	2 00 "
2 car inspectors, each,	2 00 "
Manager between Philadelphia and inclined plane,	2 50 "
4 agents for passenger trains each,	2 00 "
5 " " burthen, " "	1 50 "
Conductor of State cars,	1 25 "
Master Machinist,	4 00 "
2 Foremen of workshops, each,	2 00 "
18 Machinists, pay varying from 1 00 to	2 00 "
9 Smiths, " " " 1 50 to	1 92 "
9 Assistants, each,	1 25 "
Engineer of stationary engine at workshop,	1 16 "
Watchman,	1 16 "
2 Managers, at inclined planes, each,	2 50 "
2 Engineers " " "	2 00 "
2 Firemen " " "	1 25 "
2 Riggers " " "	1 50 "
11 Signal men, and assistants, "	1 25 "
26 Engineers of locomotives, "	2 00 "

33	Firemen of locomotives, each,	-	-	-	1	25	"
19	Watermen,	-	" -	-	-	1	00	"
33	Woodmen,	-	-	" -	-	1	00	"

The superintendent in his report dated October, 1837, states as follows: "The heavy locomotives now used for the transportation of freight are capable of drawing thirty-five cars, each with a load of three tons, or one hundred and five tons, exclusive of the cars, engine, and tender. If their weight be added, the whole will be one hundred and ninety tons." "The average number of cars to each engine, actually hauled during the season, falls far short of the number just given; this is owing to the irregularity and decrease of business which prevailed, and to the rule, which for the accommodation of the trade was adopted, of starting a train whenever one of sufficient size to justify the expense had accumulated, without delaying, and increasing the expense of the transporters by waiting for a full one.

The number of locomotive engines on the road at the date of the last report was thirty-six, of which, twenty-seven were in good order. The daily duty of the engines is to run from the head of one inclined plane to the head of the other, a distance of seventy-seven miles; between the foot of the Schuylkill plane and Philadelphia, a distance of three miles, two engines are generally kept employed in taking the trains to and fro: from the Columbia plane to the canal basin, horse power is used, the distance being only one mile.

On Steam Engines, principally with reference to their Consumption of Steam and Fuel. By J. Parkes.

This is the second and concluding communication on this subject. In the former, the generation of steam was more particularly considered (see *Athenæum* No. 601); in the present, its application when generated. These are distinct questions, as it is the economy of steam which constitutes the dynamic perfection of a steam engine, whereas it is the economy of heat in supplying that steam which constitutes the perfection of the boiler as an evaporative vessel. These economic properties are totally independent of each other; they may co-exist in a maximum degree, or in very different degrees, and the degree of perfection which any particular class of engines, or which the particular engines of any class, possess, is known from the weight of fuel burnt, of water evaporated, and the mechanical effect realized. As long as engines were constructed with but few varieties, or identical in their forms, the performance of one was a sufficient indication of the performances of all; but new forms of engines and new modes of practice being now introduced, a comparison of the performance on the several systems is a matter of deep practical and scientific interest. With the view of effecting this object, the author has collected all the authentic facts within his reach, and reduced them to common standards of comparison.

The effective power of steam engines may be ascertained either from the resistance overcome, or from the load upon the piston by means of the indicator: the former method being applicable to pumping, the latter to rotative engines. But the effective power of steam in pumping engines, as thus ascertained, is far below the real effective power of the steam, and no exact comparison can be made by these means between the effective power of the steam in the two classes of engines. The useful effect is not synonymous with a true measure of effective power, since the duty is the true use-

ful effect in a Cornish engine. The indicator when applied to the Cornish engines enables us to ascertain the absolute, but not the effective, power, so as to compare it with that of the rotative engine, since the friction of the engine and the load cannot be separately determined. The absolute power of the steam may also be ascertained from the relative knowledge of the elastic force of steam corresponding with the ratio which the volumes of water bear to each other. This theoretical estimate requires, however, several corrections; among which the steam condensed by contact with colder surfaces, the steam consumed in filling useless places, and that lost by priming, must be particularly noted. The relative performance of pumping engines is well expressed by the term "duty," that is, the number of pounds raised one foot by a given quantity of fuel; and of rotative engines by the term "horse power," that is, the number of pounds raised one foot in a minute, divided by 33.000 lb., the standard measure of a horse. The performance of the rotative engine may also be estimated by duty, and of pumping engines by horse power. The results of these computations for several engines are tabulated in this communication. The sum of the latent and sensible heat being constant for steam of all elasticities, the expenditure of both power and heat is truly measured by the weight of water consumed as steam; this measure is free from all uncertainty, and independent of all theory; the weight of water as steam equivalent to the production of a horse power in each engine, and the duty effected by one pound of steam, will denote the positive and relative efficiency of the steam and the heat. These indices of efficiency being referred to some standard, we learn, from the preceding data, the precise value of each engine in its use of steam and fuel; of its boiling apparatus, as a generator of steam; of the comparative efficiency of the steam and coal, or economy of power and fuel. The results which may thus be obtained are also exhibited in tables, accompanying the communication. The power resulting from the expenditure of equal weights of water, as steam, being known, the boiler may be connected with the engines, and the relative extent of heating surface employed to furnish their power, shown. It will thus appear that equal measures of surface are quite inadequate to supply equal power, with equal economy, to different classes of engines. These results are tabulated in great detail, and it appears that the Cornish engineers now employ nearly eight times as much boiler surface for equal nominal power as that given by Watt's practice. But taking into account the fuel burnt per horse power per hour in the two cases—the Cornish engine consuming $2\frac{1}{4}$ lb. per horse power per hour, and Watt's engine $8\frac{1}{4}$—the true relation of the boilers is as 19 to 1. Many other relations of a similar striking character may be deduced from these tables. The detailed results of the experiments by Smeaton in 1772, on his improved Newcomen engine at Long Benton—by Watt, in 1786, on his rotative condensing engine, at the Albion Mills—are recorded in these tables; and it appears, that the economy of the latter as regards steam and fuel, was double that of the former, and approached very nearly to perfection in the use of power obtainable on that principle. The next great advance in the economy of fuel and power, is that made by the Cornish engineers, whose performances, both with pumping and rotative expansive engines, far exceed any attained with the common unexpansive condensing engines. The superiority of two of these engines in 1835, doing a duty of 80 millions, exceeds the engines of Watt and Newcomen by $2\frac{1}{2}$ and 5 times in economy of power, and by $3\frac{1}{2}$ and 7 times in economy of fuel.

The obtaining a standard measure of duty is of great importance; a heaped

measure as a bushel of coals is highly objectionable, as the weight of such measure will vary from 84 to 112 lb. In the Cornish reports, the bushel is fixed at 94 lb. weight as the standard of comparison, but some portion of a ton or one pound would be a better standard. Other combustibles, however, as coke, peat, &c., may be used partially, or to the exclusion of coal, and under these circumstances some other standard of comparison is necessary; and with this view the author suggests a pound of water in the form of steam as the best standard of duty. The work done by a given quantity of water as steam is a sure index of the quality of the steam engine; it is a measure unaffected by variable calorific agents, and, so long as engines continue to be worked by steam, so long will the performance of different engines be accurately gauged by their respective expenditures of water as steam. The accuracy of this measure depends on the physical fact of the constancy of the latent and sensible heat in steam of all temperatures. The author has recorded twenty-eight experiments, made on twenty-eight different days, on vaporization from the boiling point to 60 lb. pressure above the atmosphere, which present a remarkable confirmation of the above law, and show that the relative efficiency of steam in engines is due to the manner of using it, and not to any change in its chemical constitution at different pressures. The manner of conducting these experiments, and the precautions taken to insure accurate results, are detailed with great minuteness.

The author next proceeds to treat of the Locomotive Engine, and to discuss, compare and tabulate the facts relating to this engine in the same manner as he has done those of the stationary class. The qualities of the boiler of the locomotive as an evaporative vessel had been discussed in the first communication. The locomotive differs from the fixed non-condensing engine only in the use of the blast, and the same method of measuring the effects of the steam are applicable to both. Experimenters on the locomotive have generally attempted to determine the amount of resistance opposed to its progress in preference to ascertaining the power expended in overcoming the resistance. The exact solution of either of these questions would furnish all that is wanted; but the ascertaining the total resistance by an analysis of its several constituents is attended with great difficulties, as the forces to which they are to be referred are so exceedingly numerous and variable, that the assigning the exact value to each at any one velocity has hitherto eluded the talents of those who have pursued this method. M. de Pambour was the first analyst whose labours will require attention. The results given by this author in his practical treatise on locomotive engines on railways were compared by Mr. Parkes with the results which he had obtained when experimenting on an engine of precisely a similar character, and discrepancies presented themselves which appeared totally irreconcileable. These and other circumstances led the author to consider, whether the resistance to traction would properly be deduced from the laws of gravitation, or whether any certain results would be derived as to the amount of resistance on a level from observations on engines and trains moving down inclined planes. The great object seemed to be to discover some criterion of the mechanical effect produced by a locomotive at all velocities, which would apply as practically and as distinctly to a locomotive as duty to a pumping engine, or horse power to a rotative engine. If this were possible, it seems of far less importance to distinguish the precise value of each particular unit of resistance, than to determine the relative sum of resistance and the relative expenditure of power at all velocities and under all circumstances. Now the term duty may be applied in the

strictest sense of the term to the work done by the locomotive engine; for whether the engine drag a load whose resistance is 8 lb. per ton, or whether a weight of 8 lb. for each ton of matter moved descending over a pulley and attached to the load, be considered as the moving force, the result is the same. If, then, the tractive force, or resistance, per ton of matter in motion, which is the real load on the engine, be ascertained, the whole effect is found by multiplying this sum by the space passed over in feet; and the consumption of water as steam and of coke, being known, we have all the elements requisite for determining the duty performed by the steam or coke. The pressure against the pistons may be deduced from the sum of the resistances first calculated on the assumed resistance overcome at the velocity of the engine in each experiment; and the pressure on the pistons may also be deduced from the ratio of the volumes of the steam and water consumed. The results which may be obtained on these principles are tabulated, from the experiments of M. de Pambour, Robert Stephenson, and Dr. Lardner. In another table, the author has recorded the reduction of each of these experiments to terms of horses' power, and has exhibited under that denomination the absolute power resulting from the steam used—that is required to overcome the assigned resistance—their differences—and the power which balances the gross and useful duty. The construction of these most elaborate tables is described in great detail, and the consequences which follow from the tests thus obtained are fully stated; and the author comes to the conclusion, that results inconsistent with the capabilities of the locomotive are perceptible in almost every one of the experiments. A condensing engine placed on wheels, with water of condensation transported for its supply, and made to drag a train along a railway, would require the same expenditure of water as steam, to produce a given effect, as if fixed; a non-condensing engine also is one and the same machine, whether fixed or locomotive, excepting that the latter must consume more power than the former, to do equal work, at like pressure, by the amount of the additional resistance arising from the contraction of its eduction pipes, in order to produce a fierce blast of steam through the chimney. From these and other causes the fixed non-condensing engine must be the more economical of the two; but if the results derived from M. de Pambour's data be correct, we must acknowledge the fixed non-condensing engine, with its simple atmospheric resistance, to be far inferior in economy of steam to the locomotive, with its plus atmospheric resistance. The experiments by Dr. Lardner were made for the purpose of determining the resistance opposed to progressive motion on railways. They consisted in dismissing trains at various speeds from the summit of inclined planes, and in observing their velocity when it became uniform, the resistance at such velocity being equal to the accelerating force of gravity down the inclined plane. The results of these are tabulated in the same manner as the preceding, and the most singular discrepancies present themselves. For instance, it would appear that in one particular case a duty of double the amount of that effected by the condensing engine was performed by an equal expenditure of power; that compared with a fixed non-condensing engine at equal pressure, the locomotive, though labouring against the heavy counter-pressure of the blast from which the other is free, is assumed to have performed equal work with less than one-half the expenditure of power. That if the resistance assigned by Dr. Lardner as opposed to the progressive motion of the train be correct, the efficiency of the steam in the locomotive is more than double that obtained by the best condensing engines; more than treble that derived from

stationary non-condensing engines, and equal to the performance of a Cornish expansive engine, doing a fifty million duty with a bushel of coals. With such results before us, the resistances assigned as opposed to, and overcome by, the locomotive at different velocities, must be regarded as utterly inconsistent with reality, and as resting on no solid foundation. The preceding results show also that errors have crept in by the adoption of the theoretical method of reducing undulatory surfaces to a level. M. de Pambour extends the length of the road as a compensation for the acclivities, or for the help afforded by the bank engines, and Dr. Lardner diminishes the time of the trip to that which he assumes would be occupied in performing it on a dead level. If the principles on which these corrections for the acclivities and declivities are made be correct, other facts than we are at present acquainted with must be taken into account before it can be demonstrated that a given power will convey a given load at some certain increased velocity along a level, compared with the actual velocity along any given undulating line. The resistances which enter into the composition of the sum of the forces are ever varying to such an extent that it may be doubted whether the theoretical level be not a pure fiction with reference to the practical results of the experiment.

The effective power of a locomotive engine, or the excess of power after overcoming its proper friction and the resistance from the blast, is solely expended in the generation of momentum. This, which is the product of the mass and the velocity, represents the useful mechanical effort exerted by the steam, and may always be ascertained under all the practical circumstances of railway traffic. The consumption of power as water, in the shape of steam, is a third quantity which may also be readily ascertained. The application which may be made of the above data is comprehended in the following propositions. First, that equal momenta would result at all velocities from an equal amount of power expended in equal times by the same engine, if the forces opposed to progressive motion and to the effective use of steam in the engines were uniform at all velocities. Secondly, the difference between the momenta generated by a unit of power in a given time at various velocities, measures the difference in the sum of the resistances opposed to the power at those velocities. Having ascertained the gross weight of an engine, tender, and train—their mean velocity—and the expenditure of water as steam during the trip, simple computations will inform us of,

1. The mechanical effect realized by a given power at all velocities.
2. The total increase or decrease of resistance at all velocities.
3. The ratios which the increase or decrease of resistance at different velocities bear to the ratios of those velocities.

Two other results also follow from the above, and which may be termed the commercial results, viz. the amount of gross and useful tractive effect realized by an equal expenditure of power at all velocities. The difference between these is a useful quantity in a practical sense, being the costly waste of power incident to the locomotive functions of the engine and tender over and above the waste arising from the unascertained and ineffective portion of the whole power required for the blast. The reductions and computations necessary for the exhibition and development of these views are contained in two tables. They relate to forty-nine experiments, being those already referred to, and those by Mr. N. Wood, on the Great Western and London and Birmingham Railway, and some others. One of these tables contains the velocity of the engines, the consumption of water as steam,

the loads, the absolute momenta per second; the momenta generated by equal power in equal times, viz. by one pound of water as steam per second; the weights of the gross and useful loads moved by equal powers, viz. by one cubic foot of water as steam, at the velocity of each experiment, with various other elements. The other table contains a summary of the ratios of the velocities and of their squares, brought into juxta-position with the ratios of the power expended to produce equal momenta, equal gross and equal useful effects, by the comparison of pairs of experiments on the engines given in the preceding table. This table also shows the influence of velocity in the expenditure of power to produce equal mechanical and equal commercial effects; and the amount of loss attributable to the increase of resistance at the higher velocities. The author discusses in great detail the various circumstances of these experiments, and the inferences and practical conclusions which may be deduced therefrom: and comes to the conclusion, that the determination of the performance of the locomotive engines by the methods here set forth is as practicable, exact, and demonstrative of their relative powers and dynamic excellence, as the determination of duty done by pumping engines. The intensity of the pressure on the opposite side of the piston arising from the blast has been but imperfectly stated. By some, the discharge of the steam has been likened to a jet, and considered continuous. But an attentive observer can appreciate by his ear that an interval exits between the alternate discharges of steam from the two cylinders. That these jets are periodic and not continuous, is also distinctly evidenced by the audible pulsations in the chimney, even at the very highest velocities of an engine, and their duration may be measured at lower speeds. Upon this intermittent action of the blast depends, in a great measure, the resultant pressure against the piston, and the production of a sufficient current of air through the fire, both which effects would be materially changed in intensity by the substitution of a continuous for a periodic current. The precise duration of the jet, or of the time of the steam evacuating the cylinder, can only be determined by direct and careful experiments; but its period may be ascertained within definite limits; for since a single discharge is completed within the time occupied by the piston in accomplishing a half stroke, and the pauses between two successive discharges are distinctly preceptible, a single blast cannot occupy the fourth part of the time of the revolution of the crank shaft, and very probably does not exceed the eighth part, or the period of a quarter stroke of the piston. Under no circumstances, then, can the pressure from the blast oppose the piston much longer than during one-fourth of the stroke. With an active pressure, then, of 30 lbs. per square inch, the mean resistance from the blast would not be greater than seven and a half pounds, and with a pressure of fifteen pounds not greater than three and three-quarter pounds per square inch, against the pistons. The author then proceeds to cite several observations and experiments made by himself, which are confirmatory of the preceding argument respecting the blast, and he was led conclusively to the fact, that one-fifth of the power of the engine experimented upon, at working pressures of twenty pounds and fifteen pounds was absorbed in blowing the fire; and that the escape of the steam from the cylinder was four times swifter than the motion of the piston.

The author lastly treats of the expenditure of power for a given effect, by fixed and locomotive non-condensing engines. But few experiments on the expenditure of steam for a given effect by non-condensing stationary engines have been made. The relative consumption of fixed condensing and non-condensing engines has been treated of by the late Mr. Charles Sylves-

ter, of Derby, whose knowledge and accurate theoretical analysis of the subject are shown by the close accordance of his conclusions with the facts established on two engines of these classes at certain working pressures. His conclusion that the relative economy of these engines will be as the quantities of steam consumed, or as 1 to 1.76 at those pressures, is accurately confirmed by the results he recorded. Mr. Sylvester also showed, that by increasing the pressure upon the same non-condensing, and by enlarging the area of the condensing engine's cylinder and air pump, so as to maintain the steam in it at a uniform pressure per square inch for all loads, the economy of the former would gradually approach and finally equal that of the latter. The results obtained in the preceding part of the paper furnish numerous comparisons between the locomotive and fixed non-condensing engines, and the consumption of the latter has been used, together with the condensing engine, as the test of the accuracy of the data of resistance assigned to the former by the various analysts. The accurate determination of the expenditure of steam by the same locomotive engine, in which the values of the friction and of the blast pressure were ascertained, admits of the consumption of water as steam for given effects being determined, and thus narrows the grounds of doubt, and establishes more correct data for ascertaining the real resistance opposed to progressive motion on railways. The application of these principles, as borne out by the experiments of the author, and their particular bearing on the experiments which have been the subject of the previous ample and detailed discussion, form the conclusion of Mr. Parkes' series of communications on steam boilers and steam engines. Athenæum.

Steam Conveyances on Common Roads.

A new company has been formed in London, for the promotion of this object, entitled the "Maceroni Common Road Steam Conveyance Company." The first report of the Committee was read at a meeting of the friends of the Company on the 29th of January. It states that "In a committee of the House of Commons in the year 1839, a most minute examination of the question had taken place, and evidence in favor of the plan, which this company is formed to carry out, had been received, whereupon Mr. Mackinnon (the chairman of that committee) observed that "the evidence respecting Col. Maceroni's invention, was most satisfactory and conclusive. He was very glad that evidence had been received, as it would greatly assist the committee in recommending a means of saving the main roads, and the interests connected with them from the ruin with which they were threatened." It was in accordance with those views the company had undertaken to introduce steam conveyance on the common roads; and it was with no small pride the committee had to announce that a carriage constructed on the principle of Col. Maceroni's invention was about to start, which would at once satisfy the shareholders and the public, and lay the foundation for its adoption by every coaching establishment throughout the kingdom. But to facilitate a speedy, uniform, and general adoption of steam conveyance upon common roads, a large and liberal aid on the part of those whose interest would be advanced thereby, was necessary. Of such aid the committee had the most positive assurances, for the road interests had by this time discovered that it was only by the common road steam-carriage, their property could be preserved, and their traffic maintained. Throughout the

country the coach proprietors, the innkeepers, and the very large body of persons who are interested in turnpike trusts, as well as the inhabitants and proprietors of every species of property upon and contiguous to the public lines of road, are at this moment looking forward with anxious hope to the success of this company, as the means whereby their activity shall be revived, and their interests preserved from ruin. A patent had been obtained for Col. Maceroni's invention, and a carriage is in course of completion at Mr. Beale's factory, at East Greenwich; and the committee are convinced that they will shortly be able to make arrangements for bringing the steam-carriages into general use, without calling for the full amount of capital suggested in the prospectus.

Col. Maceroni, in returning thanks for the toast with which his name had been coupled, said that in the course of the last twenty years many people had attempted to produce a steam-carriage that would run upon a common turnpike-road, and of these the most clever were those which had the least good luck. The principal amongst them was a Mr. James, of Birmingham, who was followed by Mr. Gurney. He, (Col. Maceroni,) had assisted the latter for about six months, until he was convinced that Mr. Gurney's plan was a failure altogether. He had served an apprenticeship, but all that he had learned was to avoid the errors of others. He had found that there must be no smoke—no noise—no chimney—and no ashes flying about. He had been asked by many editors of newspapers to give them an account of what his carriage could do. But he had invariably refused to do so, and always told them to come and ride with him, that they might judge of his performances for themselves, with their watches in their hands. The Colonel, having briefly sketched the history of his carriage, sat down amidst much applause.

Mr. Hodgson said the public would see that those carriages would maintain the traffic upon the common roads, without the dreadfully ruinous expense of the railways, and would carry them from village to village, and from town to town, by the established routes. He himself had been sceptical as to the practicability of the Colonel's plans; but upon examining the mass of evidence which appeared in support of them, conviction had been carried to his mind, and he became a sincere admirer of the invention. It was not from any knowledge of his own, his judgment had been formed, but it was from what he had seen of the evidence given upon oath, by persons who were above suspicion, who were amongst the highest rank, and the most eminent in science that this country can boast of, that this invention of Maceroni's had been satisfactorily tried and had been amply successful. He would ask, what man could doubt the complete success of the carriage, after the decided and conclusive testimony given in its favour by the Marquis of Tweedale, before the committee of the House of Commons in 1839? But it was not to be wondered at, that that conviction had not been extended more widely, that it was obstructed by that prejudice to which he had before referred, when they remembered that not many years had passed since six British Admirals, upon mature deliberation, solemnly pronounced that steam navigation upon the high seas, was quite impossible, and now they saw those magnificent steam-ships, of thousands of tons burthen, traversing the Atlantic with as much ease and certainty as others navigated the Thames, or crossed the British Channel.

Mining Jour.

"On the Expansion of Arches." By G. Rennie, Esq.

The expansion of solids, which has excited the attention of mathematicians since the investigations of La Hire, in 1688, on a rod of iron, is of particular importance in the construction of bridges, the security of which may be effected by the dilatation and contraction consequent on changes of temperature. Periodical motions, referable only to changes of temperature, were observed by Vicat, in a stone bridge built over the Dordogne, at Souillac, and have frequently been noticed in structures of all kinds. The different expansibilities of stone and iron have been considered an objection to the use of cast iron pillars in connexion with stone, to support the fronts of buildings; but the experiments of Mr. Adie, of Edinburgh, led him to the conclusion, that no danger is to be apprehended from a change of temperature affecting cast iron and sandstone in any great degree, as their expansion, so far as regards buildings, may be considered the same. Arguments from this source were employed against the arches of Southwark Bridge, and the experiments set forth in this communication were undertaken with a view of ascertaining the effect of temperature on these arches. Three sets of experiments were made, the first in January, 1818, when the main ribs and diagonal braces rested on their centres, and before any of the spandrils and road plates had been put upon them; the second, in August and September of the same year. The rise was measured by the insertion of small wedges, by which the rise was ascertained to about $\frac{1}{40}$th of an inch. The most extensive set of experiments were made on the eastern arch. Great care was taken in observing the thermometers, of which there were three, one in the open air, another among the ribs, and the third inserted in the iron of the rib. The result of nine experiments gave, as a mean, a rise of $\frac{1}{40}$th of an inch for 1° Fah. The effects of changes of temperature were also observed in the stone bridge, over the Thames, at Staines; after the arches had obtained their full settlement, openings were observed in the joints of the parapets immediately over the springing of the arches, and a distortion, or sinking, of the upper curve of the parapets. A wedge was inserted into some of these openings and the lowest point of its descent, in the month of January, marked. The same wedges were carefully inserted every week until May, when they would no longer enter, and the joints became firmly closed. At this period, however, the joints immediately over the crowns of the arches which had, during the winter, been quite close, were open. From these facts it followed, as a necessary consequence, that in winter the arch contracting descended, and the spandril joints opened, and in summer the arch expanding rose, and closed these joints, and opened those at the crowns. Thus the joints of the parapets, which were made of single slabs of granite for the whole height, became good indicators of the changes of temperature. It had also been observed in the Waterloo and other bridges, that joints made good in the winter with Roman cement were found crushed in summer. The details of these experiments, and of others, on the expansion of a large portion of the frieze plate, and the calculations to which they give rise, occupy the principal portion of this communication. Athenæum.

Exports and Imports of Metals in England.

We have before us the annual statement of imports and exports of metals

furnished us by Mr. John Richards, to which we referred in an earlier number, and now present to our readers an abstract, carefully made, which will be found useful, while we must refer those anxious for further details to the document itself. It appears that the exports for the past two years are as follows:—

EXPORTS.

		1838.	1839.	Increase.	Decrease.
Iron,	tons	102,766	112,559	9,793	
Steel,		1,478	2,738	1,260	
Copper cakes,		3,577	3,252		325
Copper sheets,		5,412	6,205	793	
Tin blocks,		3,871	2,931		940
Tin plates,		218,323	197,980		20,343
Lead,		9,100	9,378	278	
Spelter,		1,858	3,391	1,533	
Quicksilver,	lbs.	2,360,672	2,423,081	62,409	

From which it will be seen that the increase in the exports of iron, on that of the preceding year, is about nine and a half per cent.; steel eighty-five per cent.; copper in sheets and nails, fifteen per cent.; lead three per cent.; spelter eighty-two per cent.; and quicksilver nearly three per cent.; while in cake copper, the decrease has been about ten per cent., and there has been also a decrease in tin blocks and plates—in the former to the extent of twenty-four per cent., and the latter about nine per cent.

The imports for home consumption for the past three years are thus enumerated:—

IMPORTS.

		1837.	1838.	1839.	Increase last 12 months.	Decrease.
Iron,	tons	11,477	17,301	18,516	1215	
Steel,				23	23	
Copper,		110	171	13		158
Tin,			2	1		1
Lead,		10	85	12		73
Spelter,		2,335	3,506	4,760	1254	
Quicksilver,	lbs.	309,099	409,580	331,247		78,333

Showing an increase of nearly seven per cent. on iron, and twenty-six per cent. on spelter, in the year ending 1839, or upwards of fifty per cent. on the former, and one hundred per cent. on the latter, in the two past years. The decrease has principally been in quicksilver, which shows a diminution of about twenty-five per cent., while it should, however, be remarked, that the excess of stock in London on 1st January, 1840, over that of 1st January, 1839, is 140,000 lbs.

We do not propose, on the present occasion, to draw any deductions from the abstract made from the statement referred to, but doubt not that the figures will afford ample scope for correspondents to remark on our imports and exports of the past year, compared with those preceding. Mining Jour.

On the Cause of Steam Boiler Explosions.

Sir,—All the writers on steam-boiler explosions appear to have either for-

gotten or not to have been aware of one, if not the principal, cause of them. Persons accustomed to the operation of heating any liquid in close vessels, know, that under a considerable pressure, the intumescence within the boiler, in the bubbling up of the liquid, is checked to such an extent as to render it nearly motionless. Now let us see in what state water exists in steam-boilers with a moderate pressure on the valve. Steam and water is then in a state of intimate admixture throughout the whole mass, and the former is ready to escape, not only from the surface, but from all parts of the body of the water, on the removal of the pressure. In this tendency to escape, the steam of course cannot rush to the surface, but by carrying with it a considerable mass of the water (which surrounds and imprisons the steam) to a certain height. We will, therefore, now suppose that the pressure in the boiler is sufficient to raise the valve a little—the spring of the steam within instantly occasions a violent ebullition, and whilst there is sufficient vacant space in the boiler above the surface of the water, so that the bubbles of water may break and set free the imprisoned steam before they fill completely the vacant space, or touch the valve, it may admit an escape of the steam in sufficient quantity to carry off all the caloric which the fire underneath is supplying to the boiler every moment of time—but suppose the ebullition to become so violent on the raising of the valve as to project water and steam together through it, what is the consequence? As it is well known that steam issuing from any aperture will carry off 1000 degrees of heat, or nearly five times as much as water in similar circumstances, if the valve does not, in such an event, open to five times the space it did before, in proportion to the quantity of water, (mixed with steam) required to pass through it, the heat must accumulate in the boiler, and the pressure be consequently augmenting, notwithstanding the valve is acting, until an explosion ensues.

Thus what appears to be a paradox, is certainly true, that a valve which might be quite safe by a partial opening would become unsafe by a greater one—that is, whilst *steam alone* is passing through it, a much greater quantity of caloric is escaping than when, by a greater opening, the ebullition should be so increased as to raise the water also, and thus partially choke the aperture. It therefore follows that it is dangerous to allow a valve to open too suddenly and widely, and that it is much safer to put such a stop on it, as will so regulate the aperture that the ebullition within the boiler shall be restrained to the extent of not mounting so high as the valve, the lift of which, necessary for this purpose, depending as it does on the form of the boiler, the pressure at which it is worked, and the quantity of water in it, can only be ascertained by experience.

Bristol, Feb. 20, 1840. H. A. M.

London Mech. Mag.

"*Observations on the efficiency, or gross power, of Steam exerted on the Piston in relation to the reported duty of Steam Engines in Cornwall at different periods.*" *By* J. S. Enys.

The advantages which may result from the union of scientific and practical knowledge in the application of steam power, particularly with reference to the limits of gross power, are great, as likely to check the extravagant notions entertained by some with respect to the farther increase of duty, and to remove the disbelief of others with respect to the amount of duty actually performed. The limit of duty for atmospheric steam may be readily arrived at,

as was done by Mr. Davies Gilbert, in 1827, by estimating the weight of water which would rise thirty-four feet into a vacuum formed by the condensation of steam of atmospheric strength; whence it appears, that a higher duty than thirty millions cannot be obtained by atmospheric steam, fourteen cubic feet of water being evaporated by a bushel of coal. Tredgold, in the first edition of his Treatise on the Steam Engine, published in 1827, adopted the simpler method of multiplying the volume of steam of atmospheric strength by the pressure, for the measure of the efficiency: this principle may be extended to measure the efficiency of steam at higher pressures. The author then proceeds to show, that the Cornish engines are worked under such conditions that a large proportion of the expansive action of the steam is available on the piston, and calls attention to two necessary corrections,—first, for the deficiency of water in high steam cut off at one-fifth of the stroke; and second, for the increase of temperature of the steam during expansion in the cylinder, as derived from the steam jacket. The experiments of Mr. Wicksteed, confirmatory as they are of the very extended experiments made by Woolf at Wheal Alford, show the importance of this latter correction. Some error has also arisen from the use of the boiler pressure. The exact determination of the pressure in the cylinder is difficult, and the only recorded experiments are those by Mr. Henwood with the common indicator, and published in the second volume of the Transactions of the Institution. The quantity of water evaporated was very imperfectly recorded; it was stated by Watt as from eight to twelve cubic feet per bushel, and at present may be stated at about fourteen cubic feet, but is sometimes, with good coal and careful stoking, much higher. The author briefly alludes to the progress of improvement in Cornwall; the introduction by Woolf of high steam; the substitution of the plunger pole for the bucket pump, and the application, so recently made by Mr. James Sims, to stamping or crank engines of the arrangements which had been a long time so advantageously used in pumping engines.

Athenæum.

Great Western Electric Telegraph.

On Saturday last the following members of the select committee of the House of Commons on railways, inspected, by appointment, the electro-galvanic telegraph, at the Great Western Railway station, at Paddington, which extends from thence to West Drayton:—The Earl of Lincoln, Viscount Sandon, Sir Harry Verney, Bart., Lord Granville Somerset, Mr. Hume, Mr. Lock, and Mr. Greene. There were also present Sir E. H. Alderson, Mr. Russell, the chairman of the company, Sir J. Clark, and several gentlemen connected with mechanical and scientific pursuits. Messrs Cooke and Wheatstone (the inventors) were in attendance, and explained to the committee the principle of the working of the telegraph, and its application to the purposes of government and commerce, as well as railways. The party was engaged upwards of two hours in inspecting its mechanism and working, and appeared to attach great importance to an invention which seems destined to produce great changes in our internal communications, by its rapid and almost instantaneous agency. The Blackwall Railway Company have just adopted, the electro-galvanic telegraph on their line, which is now being laid down on an improved plan, adapted to the method of working the trains by stationary engines.

Min. Jour.

A Brick Machine.

A newly-invented brick machine has, for the last few days, been at work at the premises of Messrs. Fawsett, Preston, & Co., the highly respectable engineers of Liverpool, who have expressed their most entire and unqualified approbation of the merits of the invention; we have seen it in operation at their yard, and can bear testimony to the remarkable soundness and squareness of the bricks which it produces. Architects and builders cannot but recommend them, in preference to all hand-moulded bricks, as they are smoother and less pervious to the wet and damp, and the more capable of sustaining heavy weights. The process is very simple; the clay, after being saturated with water, is wheeled into the pugmill, worked and tempered by the machine, forced therefrom into common moulds, which pass underneath, and the bricks are delivered on boards ready to be removed to the drying ground. One horse will temper clay for, and mould 1,500 bricks in one hour; and such is the simple nature of the machine, that it is not liable to get out of repair.—*Gore's Advertiser.* Ibid.

Progress of Physical Science.

Murchison's Silurian System.

Mr. Murchison is well known as one of the leading founders and honorary officers of the Geological Society of London; and the eminent position which that society at present occupies in public estimation is in a great degree attributable to his exertions. But he is equally known to all European geologists as one of the most indefatigable votaries of the science; and the examination which for many years past he has been engaged in prosecuting, of the border counties of Wales and England (the Siluria of Caractacus,) has long been looked to, both by British and continental geologists, with great interest. It is, then, through Mr. Murchison's labours, carried on with a patience and assiduity worthy of all praise, during the last nine or ten years, that the fact has been at length established of the existence of a complete and very extensive series of fossiliferous strata, interpolated between the old red sandstone and the older slaty rocks. To this system, which rises to the surface in successive ridges in the border counties of Wales and England, and presents a normal type of hitherto unclassified deposits, its discoverer has affixed the name (now generally accepted by geologists) of *Silurian*. Shortly after the period when Mr. Murchison first announced his intention of devoting his energies to the survey of this important link in the chain, Mr. Sedgwick undertook to investigate the older and contiguous transition rocks of Wales, to which he gave the name of *Cambrian*. And we have every reason to hope, from the professor's well-known powers of observation, and the samples already offered to the society, that geology will, before long, be largely benefitted by the publication of the results of his researches. Mr. Murchison hints at the possible existence of coal-measures, capable of being advantageously wrought, beneath much of that great area of this island which is covered with the new red sandstone strata. That the coal, if reached in this situation, would in all cases pay the cost of exploring it, is of course uncertain; "and therefore," pursues our author, "believing that beneath the tracts of new red sandstone surrounding the coal-fields there may exist a due proportion of thick and valuable,

as well as of thin and profitless, coalseams, let me advise the proprietors of such tracts, before they embark in mining, to ascertain the exact geological position of the red land on which they live. If it should belong to the upper, or even to the middle portion of the new red sandstone, they would do well to desist. If, on the contrary, it should belong to the *lower* new red—and, above all, if the spot be not very far distant from the edge or boundary of a good coal-field, then let the trial be fearlessly made. But the speculator must bear in mind that coal, like every other mineral substance, is distributed in layers of variable thickness, and may, therefore, rapidly attenuate, as well as suddenly expand, within a very limited area. A remarkable example of this phenomenon has been exposed by the works at West Bromwich. This enterprise has indeed completely confirmed the geologist's view, by showing the existence of a carbonaceous formation beneath the new red sandstone; but we must fairly acknowledge that, as an experiment to prove the existence of a good *commercial coal-field* extending towards the town of Birmingham, it has for the present failed. In the meantime, the shafts of Lord Dartmouth being nearly one mile distant from what was anciently supposed to be the edge of the coal-field, where the ten-yard coal is cut off by a fault, there is every rational ground for believing that the work, when followed to the west, or towards the known coal-field, will amply repay the outlay of this spirited enterprise. The application of this principle to certain tracts on the northern and eastern sides of the coal-fields of Coal Brook Dale, and generally around the Staffordshire and Worcestershire coal-fields, must be obvious to all who have perused the preceding pages. I press the consideration of the extension of coal-measures beneath the new red sandstone of the central counties, because, though absolutely essential to a correct calculation of the probable duration of British coal, it has been entirely omitted in our national estimates. Hence political economists may be led to appreciate the value of geological inquiry."—The second part of Mr. Murchison's work contains a description and catalogue of the organic remains by which he has succeeded more especially in identifying and distinguishing his "Silurian system" from other earlier formations. Elaborate engravings are given of about 350 species, three-fourths of which are *new* to the scientific world, and it is upon this that the chief merit of our author's labours is based, since he demonstrates that, independently of all local or mineral distinctions, these Silurian rocks contain vast quantities of organic remains—a *fauna* of their own—totally distinct—except in a very few individual instances, from the fossils of the overlying systems. It is by the establishment of this fact that he is authorised to claim for his *system* the remarkable individuality and extension of character which justifies its separation from all the earlier deposits, and has enabled other geologists already to identify it in other parts of the earth's surface, of which it constitutes, according to recent information, a not inconsiderable portion. The evidence thus brought forward affords an additional proof of the important truth which, as we said above, geology had already established—that each great period of change, during which the surface of our planet was essentially modified, was also marked by the successive production and obliteration of certain races of animated beings. Not that every ancient formation was tenanted by creatures *absolutely* peculiar to it; the large natural groups of strata only (or, so to speak, systems) can be thus distinguished: but every great movement of newly deposited matter—every considerable change in the character of the deposit—was accompanied by the appearance of new races, and the destruction, and total vanishing from the face of the earth, of the great

mass of those species which previously lived, and moved, and had their being there, but whose construction or habits were probably unfitted for the new state of things which the progress of great physical revolutions had brought about. And the evidence of this fact is not confined to one locality, but is general to the whole surface of the globe which has been as yet investigated by geologists. We do not mean that these changes were everywhere synchronous: no doubt, while one district was undergoing rapid mutations, both of its mineral structure and organised existences, others were for the time stationary and quiescent, as is notoriously the case at present. But sooner or later, changes of similar character invaded these quarters also; and there is every reason to believe that, within periods of considerable extent, every part of the earth's surface was in turn subjected to analagous variations of its physical condition, giving rise to analagous changes in its organic life.—*Quarterly Review.*

Mining Rev.

Researches on Fluorine. By G. J. Knox, *M. A., M. R. I. A.*

1. *On the Insulation of Fluorine.*

"In a paper on the Insulation of Fluorine which the Rev. Thomas Knox and I had the honor of presenting to the Royal Irish Academy in the year 1837, and which was afterwards published in their Transactions, (vol. xviii. p. 127,) we proved that we had obtained fluorine in an insulated state, by showing its action upon bismuth, palladium, and gold; but being unable, from our mode of experimenting, to determine what the nature of fluorine at ordinary temperatures might be, i. e. whether it be a solid, a liquid, or a gas, we suggested that such information might be obtained from the electrolization of fluorine, using as the positive electrode some substance with which this energetic principle should not enter into chemical combination.

"Finding that, since the publication of our paper, no person had entered upon this field of investigation, I considered that the ultimate solution of this problem devolved as a point of duty upon myself; under which impression I undertook the following experiments.

"A fluor-spar stopper was made to fit the mouth of one of the fluor-spar vessels described in our former paper; that part of the stopper within the vessel being made of the form of a semi-cone, the vertex of which reached nearly to the bottom of the vessel. Through the stopper were drilled, vertically, three small holes, one through its entire length, the other two through one-third of its length. In the first was inserted a platinum wire, to be used as the negative electrode; in one of the two small holes was inserted a thin platinum wire, bound round a piece of charcoal, intended to form the positive electrode; in the other hole I put gold-leaf, litmus, or any other substance upon which I wished to try the action of the gas. Matters being so arranged, the fluor-spar vessel was about half filled with anhydrous hydrofluoric acid, the chemical purity of which had been previously ascertained. The platinum wire forming the negative electrode was raised a little above the bottom of the stopper, in order to allow the bubbles of hydrogen to rise through the perforation in the stopper, in place of mixing with the fluorine in the vessel; the wires were then placed in contact with the poles of a constant battery of sixty pair of plates, and the action was allowed to continue for the space of two hours; at the end of which time the litmus was found to be reddened, and the gold not acted upon, but a large quantity of sub-fluoride of iron formed.

In the next experiment I made use of a piece of charcoal, from which the iron had been removed by boiling it in nitric acid; in this experiment there was no subfluoride of iron formed, but the vessel was found to contain fluosilicic acid gas.

In a third experiment a piece of charcoal was employed, which had been previously freed from all metallic impurities and from silica, by being first boiled in pure nitric acid, and afterwards in hydrofluoric acid. Employing this purified charcoal as the positive electrode, I obtained no *immediate* action upon the litmus paper; but after the action had continued for two hours, it was found to be completely bleached, while the gold had undergone no sensible action. That the bleaching was not due to the action of the vapour of hydrofluoric acid was ascertained, by leaving litmus paper for several hours in the neck of a platinum retort, from which hydrofluoric acid was distilling.

The battery was now kept in action for fifteen hours, at the end of which time the vessel being examined, the litmus had disappeared, and the gold-leaf showed signs of having been strongly acted upon, having assumed a dark brownish colour, and having gathered itself into little balls, as if it had undergone the action of heat. The platinum wire was acted upon in those parts where it was in contact with the charcoal, but nowhere else.

When the platinum wire forming the positive electrode passed through the stopper to the bottom of the vessel, the hydrogen, in place of rising through the perforation in the stopper, as in the former instance, rose into the receiver, where, upon applying a light, it exploded, showing that it does not enter into combination with fluorine without the aid of heat. The presence of the vapour of hydrofluoric acid in the vessel prevented me from determining by other experiments how far fluorine was a supporter of combustion.

To determine the colour of the gas, a stopper of fluor-spar similar to the former was made to fit one of the transparent fluor-spar receivers formerly described. The gas evolved in the receiver appeared colourless.

As the action of the gas upon glass could not be determined, owing to the presence of the vapour of hydrofluoric acid, I fused in a bent tube of German glass (such as is used in organic analysis) fluoride of lead. The wire holding the charcoal was made to pass through a cork inserted in one end of the tube, the other platinum wire merely dipped into the fused fluoride. On connecting the wires with the battery, strong electrolytic action commenced, bubbles of gas were evolved rapidly at the surface of the charcoal, which, on arriving at the surface of the fused fluoride of lead, acted instantly upon the glass. The litmus paper was not bleached, nor the gold-leaf or platinum wire acted upon. Whether fluorine would act upon perfectly dry cold glass remains to be proved.

Conclusion.—Fluorine then, when obtained in an insulated state, is a colourless gas, possessing properties analogous in all respects to those of chlorine; having, like it, strong attractive powers for hydrogen and metals, but inferior to it in negative electrical energy.

2. *Note on a Compound of Fluorine with Selenium.*

When the vapour of selenium is passed over fluoride of lead fused in the platinum apparatus which I employed in obtaining the fluorides of carbon and cyanogen, a seleniuret of lead is formed, and crystals similar in form to those of fluoride of carbon are condensed in the cold receiver. These crystals are soluble in strong hydrofluoric acid. They sublime unal-

tered at a high temperature. They are instantly decomposed by water or acids, in which property they resemble the fluorides of sulphur and phosphorus.

Lond. & Edin. Philos. Mag.

On a simple mode of obtaining from a common Argand Oil Lamp, a greatly increased quantity of Light: in a letter from Sir J. Herschel, Bart.

Gentlemen,—The following simple, easy, and unexpensive mode of greatly increasing the quantity of light yielded by a common Argand burner has been used by me for some years, and is adapted to the lamp by which I write, to my greatly increased comfort. It consists in merely elevating the glass chimney so much above the usual level at which it stands in the burners in ordinary use that its *lower* edge shall clear the *upper* edge of the circular wick by a space equal to about the fourth part of the exterior diameter of the wick itself. This may be done to any lamp of the kind, at a cost of about sixpence, by merely adapting to the frame which supports the chimney four pretty stiff steel wires, bent in such a manner as to form four long upright hooks, in which the lower end of the chimney rests; or, still better, if the lamp be so originally constructed as to sustain the chimney at the required elevation without such addition, by thin laminæ of brass or iron, having their planes directed to the axis of the wick.

The proper elevation is best determined by trial; and as the limits within which it is confined are very narrow, it would be best secured by a screw motion applied to the socket on which the laminæ above mentioned are fixed, by which they and the chimney may be elevated or depressed at pleasure, without at the same time raising or lowering the wick. Approximately it may be done in an instant, and the experiment is not a little striking and instructive. Take a common Argand lamp, and alternately raise and depress the chimney vertically from the level where it usually rests, to about as far above the wick, with a moderately quick but steady motion. It will be immediately perceived that a vast difference in the amount of light subsists in the different positions of the chimney, but that a very marked and sudden *maximum* occurs at, or near, the elevation designated in the commencement of this letter: so marked indeed as almost to have the effect of a flash if the motion be quick, or a sudden blaze as if the wick-screw had been raised a turn. The flame contracts somewhat in diameter, lengthens, ceases to give off smoke, and attains a dazzling intensity.

With this great increase of light there is certainly not a correspondingly increased consumption of oil. At least the servant who trims my lamp, reports that a lamp so fitted consumes very little if any more oil than one exactly similar on the common plan.

Ibid.

Manufacture of Chlorate of Potash.

M. Pelouze has communicated a new and advantageous mode of preparing chlorate of potash. Hitherto carbonate of potash has always been decomposed by chlorine. M. Pelouze describes the inconveniences of this process, which he proposes to remedy by substituting soda for potash; by this chlorate of soda and common salt are obtained, and the chlorate of soda is converted by double decomposition into chlorate of potash by one of the cheap salts of potash which occur in commerce.

M. Pelouze also proposes to pass chlorine into milk of lime, by which

chloride of lime is obtained, and this is then decomposed by chloride of potassium.—*L' Institut*, No. 318.

Ibid.

Galle's Three Comets.

The following statement is furnished by a contributor to the Journal of the Franklin Institute whose scientific accuracy is always worthy of confidence.

"Mr. Galle, assistant observer at the Royal Observatory of Berlin, has discovered three comets in the short space of three months.

The first was discovered on the 2d of December last, passed its perihelion January 4th, and was visible to the naked eye for a few nights in January as a nebulous star of the 5th magnitude.

Galle discovered his second comet on the 25th of January; it passed its perihelion on the 12th of March, and, owing to the early arrival of Professor Encke's computation of its elements, it was seen at several places in the United States: Hudson, Ohio, Philadelphia, New Haven, &c., without, however, being visible to the naked eye.

These two comets are considered as new discoveries. Their elements do not agree with those of any that have yet been observed. Their motions may be perfectly represented by supposing them to move in a parabola, a curve which does not return into itself; so that no plausible conjecture can be formed respecting the time of their past or future appearances, except that the period of their revolutions cannot be much short of a thousand years.

Galle's third comet was discovered March 6th, and passed its perihelion on the 2d of April; its tail (visible only in a telescope) might be traced through several degrees. Its elements, compared by its discoverer in connexion with Encke, shew that it is the same as that which appeared in 1097 and 1468, and that its period is about 370 years. Its two last appearances occurred in the autumn, when it passed much nearer the earth, and hence its greater brilliancy. Neither of these comets is visible at present, the first is too remote from the earth, and the last two are lost in the morning twilight."

Iron Pyrites and Calamine.

This mineral, which is composed chiefly of iron and sulphur, and is produced in considerable quantities from some of the Derbyshire lead mines, promises, in consequence of the high price of sulphur, to be in some request. It has hitherto been considered as deads, or rubbish, and has been thrown away as such. Some gentlemen have been making inquiries for the article (known here as brazil or mundic) at Matlock, and twenty tons have been forwarded to their works, selected from the old hillocks of the Oxclose mine, at Snitterton, and the company express themselves willing to take any quantity that can be collected. Inquiries have also this week been made after calamine *(lapis calaminaris,)* and arrangements are in progress which may probably lead to a market being again opened for this once important article to the miner. Calamine is abundant in the neighbourhood of Bonsall and Matlock, and as much as 3000*l.* annually have been paid for the article in Bonsall alone; but, owing to the introduction of a foreign article, the price has of late years so much declined as to make it (except in a very few instances) no longer worth working for.—*Derbyshire Courier.*

Mining Jour.

Mechanics' Register.

Novel Mode of Conveying a Steam Engine.

It is but a short period that the Steam Engine has been used to convey Post letters on land, and now for the first time a Post letter is made the means of carrying a Steam Engine.

Messrs. Newton and Barry, of the Patent Office, Chancery lane, London, have this morning received per post, from Messrs. Chadburn Brothers, Sheffield, a perfect working steam engine, constructed on the oscillating cylinder principle, with its fly-wheel, framing, boiler, and fire place complete; the whole was enclosed in a case wrapped in paper secured with a string, accompanied with a description of its construction and mode of working. The total weight being under four ounces, was charged as eight letters, which sum being *pre-paid* at Sheffield, cost eight pence postage, and came safe to hand with its fellow penny travelers.

We understand that Messrs. Bailey, of Holborn, received last week, per post, a proof impression of an embossed metal plate, which being under half an ounce, was directed on its surface—*pre-paid* at Birmingham, and delivered as a penny post letter. Query.—How did the post-master put the post-office stamps upon it?

Chancery Lane, January 29th, 1840. Lond. Jour. Arts & Science.

Platina Wires for Musical Instruments.

A musical composer, named Fischer, has proposed the substitution of platina wires for those of steel or brass. It is (he says,) more elastic and ductile, and the sounds produced by this metal are sweeter; air and damp do not act upon it, and as it combines with iron, cords might be made of a composition of the two, which would present the advantages of each. *Athenæum.* Mech. Mag.

Gas Lights in London.

For lighting London and its suburbs with gas, there are—

18 public gas works.

12 do companies.

2,800,000*l.* capital employed in works, pipes, tanks, gas-holders, apparatus.

250,000*l.* yearly revenue derived.

180,000 tons of coals used in the year for making gas.

1,460,000,000 cubic feet of gas made in the year.

134,300 private burners supplied to about 40,000 consumers.

30,400 public or street do. N. B. about 2650 of these are in the *city* of London.

380 lamp lighters employed.

176 gas holders; several of them double ones, capable of storing 5,500,000 cubic feet.

890 tons of coals used in the retorts on the shortest day, in 24 hours.

7,120,000 cubic feet of gas used in the longest night, say 24th December.

About 2500 persons are employed in the metropolis alone, in this branch of manufacture.

Between 1822 and 1827 the quantity nearly doubled itself, and that in five years.

Between 1827 and 1837 it doubled itself again. Ibid.

LUNAR OCCULTATIONS FOR PHILADELPHIA, JULY, 1840.

Angles reckoned to the right or westward round the circle, as seen in an inverting telescope. ☞ For direct vision add 180° ☜

Day.	H'r.	Min.	Star's name.	Mag.	From Moon's North point.	From Moon's Vertex.
23	11	30	*Im. g Pleiadum,	5, 6	102°	57°
23	12	16	Em.		293	247
23	11	44	*Im. e Pleiadum,	5	133	89
23	12	27	Em.		264	215
23	11	51	*Im. c Pleiadum,	5	103	58
23	12	38	Em.		294	245
28	6	55	Im. Venus' centre		106	154
28	7	34	†Em.		206	251

* Pleiades rise occulted, at 12h. 1m.
† Venus sets occulted at 7h. 22m.

Meteorological Observations for February, 1840.

Moon.	Days	Therm. Sun rise.	Therm. 2 P.M.	Barometer. Sun rises.	Barometer. 2 P.M.	Wind. Direction.	Wind. Force.	Water fallen in rain.	State of the weather, and Remarks.
				Inch's	Inch's			Inches.	
	1	23	27	30.15	30.12	N.	Calm.	.62	Snow—cloudy.
⊗	2	7	29	.25	.16	N.W.	do.		Clear—do.
	3	15	27	29.90	29.93	W.	do.		Clear—cloudy.
	4	5	15	30.16	30.20	W.	do.		Clear—clear.
	5	4	25	.35	.30	S.W.	do.		Cloudy—do.
	6	19	43	.20	.14	E.S.W.	do.	.17	Clear—rain.
	7	44	48	.00	.10	W.	do.		Cloudy—clear.
	8	39	42	29.96	29.96	S.E. N.W.	do.		Rain—do.
	9	36	41	.94	.76	W.E	do.	.43	Cloudy—rains.
☾	10	49	59	.45	.45	E S W.	do.		Fog—cloudy.
	11	30	36	.65	.70	N W.	Brisk.		Clear—do.
	12	21	40	30.00	30 00	W.	Moderate.		Clear—do.
	13	34	49	.00	.15	W.N.	do.		Lightly cloudy—do. do.
	14	34	50	.05	.05	E.	Brisk.		Cloudy—rains.
	15	31	37	29.95	.10	W.	do.		C ear—do.
	16	24	36	30.40	.40	N S.	Moderate.		Clear—do.
☹	17	30	44	.20	.22	S.	do.		Partially cloudy—do. do.
	18	40	48	.20	.20	S.E.E.	do.	.50	Fog—rain.
	19	41	54	.20	.29	N.	do.		Fog—do.
	20	48	68	.10	29 97	S.W.	Brisk.	.4	Cloudy—shower.
	21	42	52	.30	30.30	W.	Moderate.		Clear—do.
	22	34	54	.15	.20	E.S.E.	Ca'm.		Clear—cloudy.
	23	54	68	29.95	29.80	S.W.W.	Brisk.		Fog—hazy.
☽	24	44	44	.95	.95	N E.	Moderate.		Cloudy—clear.
	25	40	44	.90	.90	W.	do.		Cloudy—clear.
	26	37	61	.90	.80	S W.	do.		Cloudy—clear.
	27	50	52	.85	.85	N W.	do.		Cloudy—do.
	28	38	42	30.05	30 05	W.	do.		Cloudy—do.
	29	35	58	.05	.03	W.	do.		Clear—do.
	Mean	32.79	44 58	30.04	30.03			1.72	

		Thermometer.	Barometer.
Maximum height during the month.		68.00 on 20th. and 23rd.	30.40 on the 16th.
Minimum	" "	4 00 on 5th.	29.45 " 10th.
Mean		38.685	30 035

METEOROLOGICAL REPORT

FOR THE STATE OF PENNSYLVANIA,

Collated from returns made to the Committee on Meteorology of the Franklin Institute of the State of Pennsylvania, for

MAY, 1840.

	County.	Town.	Observer.	Thermometer. 7, A. M.	2, P. M.	9, P. M.	Maximum.	Minimum.	Mean.	Days omitted.	Register. Lowest.	Mean.	Days omitted.	Barometer. 7, A. M.	2, P. M.
1	Philadelphia,	Philadelphia,	J. M. Hamilton,	63.41	71.06	65.14	86.00	46.00	66.54	3	39.00	52.82	3	30.00	29.
2	Montgomery,														
3	Bucks,	Newtown,	L. H. Parsons,	60.05	68.52	54.30	84.25	40.50	60.96	.	37.00	48.85	.	29.87	29.
4	Lehigh,														
5	Northampton,	Easton,	Lafayette College,												
6	Monroe,	Stroudsburg,	A. M. Stokes,	51.34	72.15	57.44	90.	36.00	60.38	11⅔	....	....	.	29.46	29.
7	Pike,														
8	Wayne,														
9	Susquehanna,	Silver Lake,	E. Rose,	53.89	71.61	58.41	88.	32.00	61.30	3	28.00	47.25	3	27.99	27.
10	Luzerne,	Wilkesbarre,	W. F. Dennis,												
11	Schuylkill,														
12	Berks,	Reading,	C. F. Egelmann,												
13	Chester,														
14	Delaware,	Haverford,	Haverford School,												
15	Lancaster,	Lancaster,	Conservatory of Arts,	57.94	72.45	60.58	86.	40.50	63.66	⅓	38.00	52.84	.	29.45	29.
16	York,														
17	Lebanon,														
18	Dauphin,														
19	Northumberland,	Northumberland,	Andrew C. Huston,	58.32	68.60	61.39	83.	40.00	62.77	.	34.00	47.13	.	29.39	29.
20	Columbia,	Danville,	C. H. Frick.	57.46	75.62	62.18	87.	46.00	65.09	8⅓	33.00	51.65	8	29.40	29.
21	Bradford,														
22	Tioga,														
23	Lycoming,														
24	Union,														
25	Mifflin,														
26	Juniata,	Mifflintown,	J. A. Rinkead,	49.01	71.14	57.86	90.	32.00	59.35	3	....	....	.	29.39	29.
27	Perry,														
28	Cumberland,	Carlisle,	Prof. W. H. Allen,	56.84	70.29	59.29	86.	37.00	62.14	.	36.00	50.87	.	29.31	29.
29	Adams,	Gettysburg,	Prof. M. Jacobs,	56.83	70.43	58.56	87.50	38.00	61.94	.	35.50	49.23	.	29.35	29.
30	Franklin,														
31	Huntingdon,	Huntingdon,	Jacob Miller,	57.13	72.19	58.29	89.	39.00	62.54	.	....	....	.	29.29	29.
32	Centre,	Bellefonte,	John Harris,	52.47	72.40	57.72	92.	35.00	60.86	4⅓	....	....	.	29.24	29.
33	Potter,														
34	M'Kean,	Smithport,	Richard Chadwick,	48.84	72.00	48.35	94.00	34.00	56.40	1⅓	27.00	40.00	.	28.09	28.
35	Clearfield,														
36	Cambria,	Ebensburgh,	Richard Lewis,	51.42	66.87	53.87	90.00	32.00	57.39	2	29.00	44.81	4	27.78	27.
37	Bedford,	Bedford,	Samuel Brown,	59.91	69.37	63.58	87.00	38.40	64.29	.	....	....	.	29.19	29.
38	Somerset,	Somerset,	George Mowry,	54.31	63.83	54.82	81.50	36.00	57.65	⅓	33.50	48.18	.	27.93	27.
39	Indiana,	Indiana,	Richard White,	68.35	71.35	54.61	96.00	36.00	64.77	.	28.00	45.22	8	28.59	28.
40	Jefferson,	Rose Cottage,	C. C. Gaskell,												
41	Warren,	Warren,	C. S. Brown,	56.68	68.73	63.86	88.00	39.00	63.19	.	36.00	47.10	5	28.79	28.
42	Venango,	Franklin,	Wm. Connely,	46.	74.48	61.45	95.00	24.00	60.64	.	....	....	.	....	29.
43	Armstrong,														
44	Westmoreland,														
45	Fayette,	Uniontown,	J. P. Weithers,	59.37	71.55	60.58	92.00	36.00	63.83	.	....	....	.	28.94	28.
46	Green,														
47	Washington,	Cannonsburg,	Jno. H. Kennedy.	49.13	73.94	59.16	92.00	33.00	60.74	.	33.00	49.00	.	28.97	29.
48	Alleghany,	Pittsburgh,	G. P. Schiveley,	58.84	70.05	60.97	87.00	40.00	63.29	.	....	....	.	29.19	29.
49	Beaver,	Beaver,	Wm. Allison,	60.74	70.40	65.93	86.00	48.00	65.69	⅔	....	....	.	29.34	29.
50	Butler,	Butler,	Jacob Mechling,	55.74	73.65	63.65	89.00	40.00	64.35	.	....	....	.	28.81	28.
51	Mercer,	West Greenfield,	S. Campbell,	60.35	71.25	60.53	90.00	42.00	64.05	.	42.00	58.05	.	28.67	28.
52	Crawford,	Meadville,	J. Limber,	60.69	70.00	60.67	91.00	42.00	63.79	1⅓	33.00	48.17	1	28.67	28.
53	Erie,	Erie,	Park & Reid,	59.32	65.42	57.00	82.00	39.00	60.58	1	28.00	47.02	1	29.46	29.

Days omitted.	Register. Lowest.	Register. Mean.	Register. Days omitted.	Barometer. 7, A. M.	2, P. M.	9, P. M.	Maximum.	Minimum.	Mean.	Days omitted.	Weather. Clear.	Cloudy.	Days omitted.	Rain.	Snow.	Rain and Snow.	Thunder Showers.	Rain in inches.	North.	N. N. E.	N. E.
3	39.00	52.82	3	30.00	29.93	29.99	30.47	29.35	29.97	2⅔	20	6⅔	4⅓	....	....	....	..	....	1	1⅓	6⅓
.	37.00	48.85	.	29.87	29.88	29.89	30.37	29.07	29.88	.	17⅓	12	1⅔	8	....	....	..	3.906	⅔	⅔	4⅔
1⅔	....	....	.	29.46	29.46	29.45	29.90	28.75	29.46	9⅔	8⅓	11⅓	11⅓	7	....	....	..	2.950	2⅓	.	1
3	28.00	47.25	3	27.99	27.99	27.96	28.50	27.25	27.98	3	14⅔	10⅔	5⅓	4	....	....	..	1.670	.	.	.
⅓	38.00	52.84	.	29.45	29.44	29.45	29.90	28.74	29.45	⅓	19⅓	11⅓	⅓	7	....	....	..	2.030	1⅓	⅔	2⅔
.	34.00	47.13	.	29.39	29.33	29.38	29.82	28.63	29.37	.	14	17	.	11	....	....	1	2.731	3⅓	⅓	2⅓
8⅔	33.00	51.65	8	29.40	29.40	29.38	29.60	28.00	29.40	8⅔	11⅓	11	8⅔	....	....	....	..	.....	⅔	.	⅔
3	....	....	.	29.39	29.36	29.38	29.83	28.14	29.38	3	14⅔	12⅔	3⅓	8	....	....	..	3.100	⅔	.	1⅓
.	36.00	50.87	.	29.31	29.29	29.29	29.72	29.64	29.30	.	16⅔	14⅓	.	11	....	....	..	2.422	⅔	⅓	1⅔
.	35.50	49.23	.	29.35	29.35	29.33	29.74	28.68	29.34	.	17⅔	13⅓	.	8	....	....	2	2.638	⅔	.	4⅓
.	....	....	.	29.29	29.28	29.25	29.68	28.62	29.24	.	17	14	.	10	.	....	..	3.272	.	.	.
4⅓	....	....	.	29.24	29.23	29.20	29.90	29.46	29.22	3⅔	14	12⅔	4⅓	.	.	....	..	5.770	⅔	.	3⅓
1⅔	27.00	40.00	.	28.09	28.11	28.10	28.55	27.23	28.10	1⅔	17	12⅓	1⅔	.	.	....	..	2.482	⅓	.	⅓
2	29.00	44.81	4	27.78	27.78	27.78	28.12	27.10	27.78	2	10⅔	17⅓	2⅔	10	2	....	..	4.458	⅔	.	1⅓
.	....	....	.	29.19	29.14	29.12	29.57	28.48	29.15	.	15	16	.	.	.	....	..	.....	.	.	.
⅓	33.50	48.18	.	27.93	27.91	27.91	28.23	27.30	27.92	⅓	13	17⅓	⅔	9	1	....	..	3.975	⅔	.	⅔
.	28.00	45.22	8	28.59	28.56	28.55	28.90	27.90	28.57	.	17	14	.	12	....	....	..	3.180	.	.	⅔
.	36.00	47.10	5	28.79	28.79	28.79	29.16	28.10	28.79	.	19⅔	11⅓	.	5	....	...	1	1.367	1⅓	⅓	1⅔
.	....	....	.	....	29.02	....	29.90	28.44	29.02	20⅓	7⅓	3	20⅔	10	....	....	..	3.423	.	.	.
.	....	....	.	28.94	28.91	28.93	29.80	28.09	28.93	.	22⅓	8⅓	.	....	....	....	..	.....	⅓	.	4
.	33.00	49.00	.	28.97	29.00	29.00	29.63	28.08	29.00	.	.	.	.	10	....	....	..	4.172	.	.	1
.	....	....	.	29.19	29.17	29.18	29.50	28.55	29.18	.	19⅔	11⅓	.	....	....	....	..	.....	.	⅓	⅓
⅔	....	....	.	29.34	29.30	29.37	29.70	28.66	29.34	⅓	15⅓	15	⅔	....	....	....	..	3.190	1	.	3⅓
.	....	....	.	28.81	28.80	28.82	29.10	28.30	28.81	.	20	11	.	8	...	....	..	3.750	.	.	3⅓
.	42.00	58.05	.	28.67	28.65	28.62	28.94	28.05	28.65	⅓	17⅓	13⅓	⅓	11	....	....	..	2.980	5⅔	.	.
1⅔	33.00	48.17	1	28.67	28.67	28.67	28.97	28.00	28.67	1⅓	15	14⅔	1⅓	11	....	....	..	2.983	3⅔	.	⅔
1	28.00	47.02	1	29.46	29.43	29.46	29.80	29.06	29.45	.	22	9	.	6	....	....	2	2.190	1⅓	⅓	5⅓

	Winds.																		Hygrometer.					
	North.	N. N. E.	N. E.	E. N. E.	East.	E. S. E.	S. E.	S. S. E.	South.	S. S. W.	S. W.	W. S. W.	West.	W. N. W.	N. W.	N. N. W.	Calm.	Days omitted.	Dew-point.	Days omitted.	Diff. therm. and dew point.	Wet Bulb.	Days omitted.	No. of Report.
.	1	1⅓	6⅓	.	2	1	2	1	⅔	1⅓	4⅓	⅔	1⅓	2⅔	4⅔	⅓	.	2⅓	....	.	... .	....	.	1059
06	⅔	⅔	4⅔	1⅓	.	⅔	4⅓	1	⅔	⅓	5⅔	1	.	⅓	8	1⅓	.	⅓	....	.	.....	....	.	1062
30	2⅓	.	1	.	4	.	1⅔	.	2⅔	.	4	.	2⅓	.	3⅓	.	.	9⅔	....	.	.....	....	.	1096
70	.	.	.	.	⅓	.	8	.	.	.	1	.	6⅓	.	3	.	9⅓	3	....	.	.....	....	.	1113
30	1⅔	⅔	2⅔	⅓	5	1	4	⅔	1⅓	1⅔	2⅓	⅔	1⅔	.	5	1⅔	.	⅓	56.23	1	.....	62.37	1	1069
31	3⅓	⅓	2⅓	⅓	⅔	.	5⅓	1⅔	6⅔	.	1	.	3⅓	.	3	⅓	2⅓	.	....	.	.....	63.79	.	1060
..	⅓	.	⅔	.	⅔	.	3⅓	.	2⅔	.	4	⅔	⅓	.	1	.	7⅔	9⅓	....	.	.....	...	.	1029
30	⅔	.	1⅓	.	3	.	5⅓	.	.	.	2	.	⅔	.	3	.	11⅓	3⅔	....	.	.....	....	.	1064
32	⅔	⅓	1⅔	.	2⅓	⅓	3	.	1⅔	.	1	⅔	3⅓	⅔	3⅓	1	11	.	....	.	.....	....	.	1156
38	2⅔	.	4⅓	.	1	⅔	7⅓	⅓	1⅓	1⅓	5	⅔	1	⅔	5	⅓	.	.	....	.	.....	....	.	1144
32	.	.	.	.	14⅔	.	.	.	.	.	.	.	16⅓	.	.	.	.	.	....	.	.....	....	.	1088
30	⅓	.	3⅓	.	1	.	5	.	1⅔	.	5	.	3	.	7	.	.	4⅓	....	.	.....	....	.	1092
32	⅓	.	⅓	.	1⅓	.	4⅔	.	⅓	.	1⅓	.	15⅔	.	3⅔	.	.	3⅔	....	.	.....	64.36	6	1095
38	⅔	.	1⅓	.	⅔	⅓	4⅓	.	2	.	2⅔	.	6⅔	⅔	5⅓	.	4⅓	2	....	.	.....	....	.	1067
..	.	.	.	.	.	.	1⅔	10	.	2	1⅓	2	2	7⅔	4	⅓	.	.	....	.	.. .	....	.	1093
35	⅓	.	⅔	.	1	.	5⅔	.	1	.	1	4⅓	1⅓	1⅔	1	.	12⅓	⅓	....	.	.....	....	.	1078
30	.	.	⅔	.	1⅓	.	8	.	.	.	3⅓	.	1⅓	.	6	.	10	.	....	.	...	....	.	1068
37	1⅓	⅓	1⅔	.	1	.	6	⅓	1	.	1⅔	.	2⅓	.	⅓	.	14⅓	⅔	....	.	....	....	.	1079
33	.	.	.	.	1	.	3⅔	.	.	.	⅔	.	.	.	5	.	.	20⅔	....	.	.....	....	.	1094
..	⅓	.	4	.	⅓	.	5	.	2	.	7⅔	.	6⅓	.	⅓	.	5	.	....	.	.....	....	.	1267
32	.	.	1	.	2⅓	.	3⅓	.	⅓	.	8	.	4⅓	.	4	.	.	7⅔	....	.	.....	....	.	1080
..	.	⅓	⅓	.	⅔	2⅔	4	⅓	4⅔	1⅓	3⅔	1⅔	4	1⅔	5	⅔	.	.	....	.	... .	....	.	1063
90	1	.	3⅓	2⅓	⅓	.	3	.	.	.	1⅓	1⅓	1	.	8⅓	⅔	7	⅔	....	.	.....	....	.	1227
30	.	.	3⅓	.	10⅔	.	1	.	⅔	.	8	.	5⅔	.	1⅔	.	.	.	....	.	.....	....	.	1083
30	5⅔	.	.	.	2	.	2	.	9	.	.	.	⅔	.	1	.	10⅓	⅓	77.61	5	.....	52.58	.	1165
33	3⅔	.	⅔	.	2	.	2⅓	⅔	3	⅔	1⅔	.	3⅓	.	4⅔	.	5	3	....	.	.....	....	.	1081
90	1⅓	⅓	5⅓	3⅓	.	⅓	⅔	⅔	2⅓	⅔	1⅓	3	3⅓	2⅓	2	⅓	3⅔	.	....	.	.....	....	.	1177